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Revision 2

Closure Plan for the Surface Impoundment System

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1. **Introduction**

This Closure Plan has been developed for the surface impoundment system (Lagoons 1, 2, 3, 4, 5A, and 5B plus two ancillary impoundment structures) located at the Framatome ANP, Inc. (FANP) nuclear fuels fabrication facility in Richland, Washington. The closure will be performed in accordance with the Washington State Department of Ecology's (Ecology's) Dangerous Waste Regulations (WAC 173-303).

The plant, located at 2101 Horn Rapids Road, Richland, Washington, has been in operation since the early 1970's, producing fuel products for commercial nuclear power reactors. Licensed by the U.S. Nuclear Regulatory Commission (NRC), the plant is currently owned and operated by FANP. The plant consists of a variety of production, production support, and waste management facilities that produce a number of low-level radioactive liquid waste effluents, many of which are also classified as mixed wastes due to their containing dangerous chemical constituents. These low-level and mixed waste liquid effluents are managed in the six-lagoon surface impoundment system located in the eastern portion of the plant. This surface impoundment system is the focus of this closure plan. The plan and associated cost estimate address both the disposition of the remaining surface impoundment inventory as well as the physical remediation and closure of the impoundment structures (six lagoons and two ancillary impoundments), ancillary equipment, and impacted environmental media.

1.1 *Regulatory Basis*

FANP's surface impoundment system constitutes a dangerous waste management unit (DWMU) requiring a written closure plan (WAC 173-303-610). A closure plan for the impoundments was submitted in 1994 in conjunction with FANP's [then Siemens Power Corporation (SPC)] Part B permit application for the surface impoundment system. Related to a Loss of Interim Status determination on the surface impoundment system under Federal Resource Conservation and Recovery Act (RCRA) regulations, FANP entered into a consent decree agreement with Ecology in April 1996 which stated, among other things, 1) that the surface impoundments would not go through the process for a final status permit, 2) that the system would instead be closed under interim status in accordance with an approved 40 CFR 265 Subpart G closure plan and in accordance with a schedule imposed in the consent decree, and 3) that in the interim, the surface impoundment system could continue to operate under its still effective State of Washington interim status and in accordance with 40 CFR 265.113(d) requirements. A substantially rewritten closure plan (EMF-

2826, Revision 0) was submitted to Ecology in October 2002 addressing closure of the surface impoundment system as will be performed under interim status standards in Ecology's Dangerous Waste Regulations (WAC 173-303-400) and the pertinent U.S. Environmental Protection Agency regulations (40 CFR 265 Subpart G) incorporated by reference therein. It defined FANP's current closure approach and estimated associated closure costs for the surface impoundment system and as such, superseded the closure plan/cost estimate submitted originally in 1994. A further revision to the Plan (EMF-2826, Revision 1), submitted in April 2003, retained the closure approach outlined in the October 2002 submittal (Revision 0) but, among other things, provided an additional level of detail in the closure cost estimates, updated the cost estimate to reflect then current (March 2003) lagoon inventories, and described protocols for the decontamination of contaminated debris. As part of the April 2003 submittal, FANP requested Ecology's formal review and approval of the Plan. Revision 2 of the Plan is being submitted to address Ecology's comments based on their review of the April 2003 Revision 1 submittal.

1.2 *General Closure Approach*

Dangerous waste closure activities covered under this plan will be limited to FANP's surface impoundments, their ancillary equipment and any debris or environmental media determined to be contaminated solely from the operation of the surface impoundment system. This Closure Plan provides the procedures to be employed to achieve clean closure of the DWMU. Clean closure will require the removal or decontamination of all dangerous wastes, waste residues, and equipment, bases, liners, soils or other materials containing or contaminated with dangerous wastes or waste residues to those levels specified in WAC 173-303-610(2)(b)(i) and (ii). Accordingly, the cleanup levels will be calculated using the Method B unrestricted land use exposure assumptions of the Model Toxics Control Act (MTCA) regulations (WAC 173-340).

In summary, the process for closure of the impoundments will involve processing the remaining surface impoundment inventory; decontaminating and removing containment system components including liners, engineered sand layers, and leachate detection equipment; dispositioning the resulting contaminated media and debris in accordance with approved Ecology protocols for environmental media and debris; conducting characterization sampling of soil beneath each impoundment; remediating or removing and disposing of contaminated soil consistent with approved protocols for contaminated media; conducting verification sampling to confirm compliance with cleanup levels; and regrading of native soils or placement of clean fill to establish acceptable surface water (storm water runoff) drainage patterns.

Environmental contamination requiring remediation under this Plan is the result of historic releases of lagoon solutions from early lagoon operations when certain of the lagoons had single liners and to a lesser extent from leakage of lagoon solutions from single-walled underground piping. These potential contamination pathways were minimized via conversion of all lagoons to a multi-liner configuration, including inter-liner leachate detection/collection capability, and upgrades to the piping system. The potential contamination pathway will be completely eliminated by emptying of the lagoons. The potential for further environmental releases related to decontamination/removal activities is minimal, based on controls described within the Plan. Any environmental releases that may occur in conjunction with the closure activities will be investigated and remediated consistent with the closure approach/objectives of this Plan.

1.3 *Closure Objectives*

The closure performance standard for dangerous waste management units under interim status facility standards is listed in 40 CFR 265.111 [as incorporated by reference in WAC 173-303-400(3)(a)]. This standard requires FANP to close the surface impoundment system in a manner that:

- Minimizes the need for further maintenance;
- Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, post-closure escape of dangerous waste, dangerous waste constituents, leachate, contaminated runoff, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere.
- Complies with the unit-specific closure requirements listed in 40 CFR 265.111 (c).

This Closure Plan has been developed to guide implementation of closure activities designed to achieve this performance standard and to certify the closure as complete and consistent with the regulatory requirements for clean closure. Impacts to environmental media, i.e., soil and groundwater, resulting from operation of the surface impoundment system will be determined as part of the closure activities. As described above, the numeric cleanup levels for these environmental media will be calculated according to MTCA Method B unrestricted land use closure criteria. Environmental remediation will be completed as necessary to achieve closure objectives.

1.4 **Closure Plan Overview/Organization**

This Closure Plan has been prepared in accordance with applicable Ecology and U.S. EPA RCRA regulations. The plan is organized into four chapters as follows:

- Introduction (Chapter 1.0)
- Facility Information (Chapter 2.0)
- Closure Procedures for the Surface Impoundment System (Chapter 3.0)
- Closure Schedule and Costs (Chapter 4.0)

2. **Facility Information**

This section provides information describing the Richland plant site, its facilities, and its operational history.

2.1 *Facility Description*

This section provides information on the FANP facility. Section 2.1.1 describes the facility location; Section 2.1.2, the operational history; Section 2.1.3, land use and zoning; and Section 2.1.4, facility description.

2.1.1 Facility Location

The FANP Engineering and Manufacturing Facility (Figure 1) is located at 2101 Horn Rapids Road just within the northern limits of the city of Richland in Benton County, Washington. The facility definition includes the active manufacturing facility within a fenced area of approximately 53 acres. The land surrounding the facility (which is also owned by FANP) is generally undeveloped, or in the case of land west of the facility, leased for agricultural purposes.

The facility is located within 320 acres of land owned by FANP which is within the Horn Rapids Industrial Park. The property is situated at approximately latitude N46°21'003" and longitude W119°18'020" in Sections 15 and 16 of Township 10N, Range 28E, Willamette Meridian. The facility itself is located in the southwest quarter of Section 15 (15-SW/4).

The property is geographically situated within the Pasco Basin in the northern portion of the Columbia Plateau, east of the Cascade Mountains. The Yakima River passes approximately 2 miles to the west, and the Columbia River is approximately 1.5 miles to the east. The nearest residential areas are 1.5 miles to the southwest.

2.1.2 Operational History

The nuclear fuel fabrication plant has been in actual operation since the early 1970's. From 1969-72 the plant was constructed and operated by an operating unit of Jersey Enterprises, Inc. known as Jersey Nuclear Company. Jersey Enterprises, Inc. was a subsidiary of Standard Oil of New Jersey.

Jersey Nuclear Company was incorporated in 1972 as Jersey Nuclear Company, Inc. In 1983, Jersey Nuclear Company, Inc. changed its name to Exxon Nuclear Company, Inc. By Stock Purchase Agreement dated December 31, 1986, Siemens Capital Corporation purchased Exxon Nuclear Company, Inc. from Exxon. Exxon Nuclear Company, Inc. changed its name to Advanced Nuclear Fuels Corporation on January 15, 1987, to Siemens Nuclear Power Corporation on August 1, 1991, and to Siemens Power Corporation on July 10, 1992. On February 1, 2001, SPC changed its name to Framatome ANP Richland Inc., coinciding with the merger of the former-SPC's parent company, Siemens AG, with that of the French company, Framatome S.A. On March 19, 2001, Framatome ANP Richland Inc. became a wholly owned subsidiary corporation of Framatome ANP, Inc., the U.S. nuclear operations corporation for the joint venture. Lastly, on September 1, 2001, Framatome ANP Richland, Inc. merged into, and took the name of, its parent company, Framatome ANP, Inc. Throughout its history, the FANP facility has operated under a license from the U.S. Nuclear Regulatory Commission (NRC).

2.1.3 Land Use and Zoning

Land use in the general area is agricultural, residential, industrial and commercial, and, to a lesser extent, recreational. The region's agricultural lands are primarily north and east of the Columbia River and south of the Yakima River and are used for dry-land and irrigated crop production and livestock grazing. The incorporated area of Richland is the closest center of residential land use. Regional industrial activities are associated predominately with agriculture or the U.S. Department of Energy’s Hanford Site. Commercial usage consists primarily of retail establishments. Recreational land uses in the area include hunting in the unincorporated areas and leisurely pursuits normally associated with incorporated residential areas.

The area immediately surrounding the FANP property is relatively undeveloped. FANP owns the adjacent property to the east, west, and south of the facility. With the exception of land to the west which FANP leases for agricultural purposes, this property is undeveloped and forms a buffer ranging from approximately 500 feet to 0.25 mile wide between the facility and other privately owned land. The U.S. Department of Energy-owned Hanford Site lies north and east of the FANP property and includes three current CERCLA National Priorities List (NPL) sites (the 100-, 200-, 300- Areas) and one former NPL site (the 1100 Area). The 1100 Area is divided into three operable units: 1100-EM-1, 1100-EM-2, and 1100-EM-3. The boundaries of the 1100-EM-1 Operable Unit abut FANP's property on the north and east. The Horn Rapids Landfill (HRL), which lies in the 1100-EM-1 Operable Unit, lies directly north of the FANP facility across Horn Rapids Road. The HRL was investigated as a potential source of soil and ground-water contamination (USDOE 1993). The South Pit portion of the HRL lies less than 500 feet northeast of the active portion of the FANP facility and immediately south of Horn Rapids Road on undeveloped FANP property. The rest of the 1100 Area in the vicinity of the FANP property is undeveloped. Further to the south, land use consists of Hanford operations support.

To the south and west of the FANP property as well as on FANP property west of the plant, irrigated agricultural activities are conducted by Tony Czebotar Farms. To the southeast, Allied Technology Group (ATG) operates a commercial low-level radioactive waste treatment and packaging facility. To the west, International Hearth Melting operates a metal melting facility and to the southwest, Plastics Injection Molding runs a plastics extrusion and molding facility.

The FANP property is zoned M-2, Heavy Manufacturing Use. The land surrounding the FANP property is zoned as follows:

- Industrial for the Federal Hanford Site to the north, northeast, and northwest. Land use is restricted to activities associated with the nuclear industry; non-nuclear-related activities may be allowed upon approval of U.S. Department of Energy (USDOE) (Benton County Code, Title 11, Ordinance No. 62).
- Agricultural (AG) to the west and southwest.
- Medium industrial (I-M) or heavy manufacturing (M-2) to the east and south.

2.1.4 Facility Description

The primary activity at the FANP facility is the manufacture of fuel rod assemblies for nuclear power reactors. Intermediate fuel products may also be supplied, namely uranium dioxide (UO_2) powder and UO_2 pellets. Manufacturing of these fuel products and associated support activities occur in a number of structures (Figure 2). Key facilities and the primary processes which occur in each of them follows.

- Dry Conversion Facility Uranium hexafluoride is converted to uranium dioxide (UO_2) powder. The powder is physically conditioned, placed into drums, and then transferred to storage or to the Uranium Dioxide Building for further processing.

- Uranium Dioxide (UO_2) Building Uranyl nitrate hexahydrate (UNH) is converted through the "wet conversion" process to UO_2. UNH is formed by the dissolution of scrap UO_2 and other uranium-containing solids in nitric acid. Byproducts of the wet conversion process are ammonium, nitrate, and low concentrations of uranium in aqueous solution.

  Following conversion in either the Dry Conversion Facility or the UO_2 Building, the UO_2 is pressed into pellets and sintered. The pellets are loaded into fuel rods which are then bundled into a fuel rod assembly. Pressing, sintering, and loading of the pellets into fuel rods is performed in the UO_2 Building.

- Ammonia Recovery Facility (ARF) One of the byproducts of the wet conversion process is ammonium (along with other ions) in aqueous solution. The purpose of the ARF is to recover the ammonia, as ammonium hydroxide, from the aqueous process solution for reuse in the wet conversion process. ARF is also now being used to recover ammonia from stored lagoon solutions as part of FANP's lagoon inventory processing activities. Ammonia recovered in excess of that needed for uranium conversion is sold for agricultural fertilizer usage.

- Engineering Laboratory Operations (ELO) Building Processes carried out in the ELO building include dissolution of uranium-bearing solids in nitric acid, followed by uranium purification of the resultant UNH through solvent extraction techniques. Organic solvents used in the process are tributylphosphate and dodecane.

- Modular Extraction Recovery Facility (MERF) This facility recovers uranium from stored containerized solid wastes and ventilation system filters. The wastes are placed in a washer/extractor unit similar to a large commercial washing machine. Uranium is extracted as uranyl nitrate from the solids via a primary nitric acid-based wash and subsequent rinse cycles. The extracted uranium is returned to the uranium purification process for recycle. Residual solids are packaged into drums pending offsite disposal.

- Silica Removal Process (SRP) Lagoon liquids are processed through the SRP to remove silica, which can be a cause of downstream processing problems in the ARF. The silica is removed by chemical precipitation. The solids are dewatered in a filter press prior to packaging for offsite disposal.

- Solids Processing Facility (SPF). The SPF recovers uranium from lagoon solids and liquids using retrieval, dissolution, separation, and dewatering equipment. The facility uses a dredge to vacuum up and pump lagoon liquids and solids (sludges) from the lagoons as a slurry. Uranium is recovered from this slurry via chemical processing. The resultant solids are processed in a filter press for dewatering prior to packaging for offsite disposal.

- Lagoon Uranium Recovery Facility (LUR). The LUR Facility recovered uranium directly from Lagoon 3 dangerous waste liquids and also recovers uranium from Solids Processing Facility (SPF) dangerous waste filtrates. Effluent from LUR may be routed for further processing through the Silicon Removal Process (SRP) prior to processing in the ARF for ammonia recovery.

- Specialty Fuels (SF) Building. Neutron-absorber fuel (NAF) is fabricated in this building. The NAF process begins with the blending of dry powders, i.e. no chemical conversion is involved; therefore there are no liquid effluents associated with the NAF processes in the SF building. In a separate area of the building, non-dangerous uranium-containing combustible wastes are incinerated. The incinerator is part of the Solid Waste Uranium Recovery (SWUR) process through which uranium is reclaimed from combustible solid wastes for subsequent use in nuclear fuel fabrication.

Other buildings at the FANP facility include, among others, several warehouses, a machine shop, a number of maintenance-related shops (painting, carpentry, welding, etc.), and an office complex.

2.1.5 Waste Management Unit Summary

The surface impoundment system consists of a series of six multi-linered lagoons located on the eastern portion of the facility. Two adjacent ancillary, albeit much smaller, lined impoundments are located on the west side of the lagoons. These two structures, referred to as the sand trench and leach pit, were used intermittently to wash/decontaminate wind-blown sands removed from the lagoons in conjunction with lagoon liner repair/replacement activities. The leach pit was also used for a number of short term tests to evaluate chemical leachants for lagoon sediments. In addition to the surface impoundments and their ancillary structures, the FANP site includes two mixed waste container storage pads and a number of exempt recycling facilities and permit-by-rule wastewater treatment units.

2.1.6 Groundwater Monitoring System

Groundwater monitoring is conducted on a quarterly basis at the FANP Horn Rapids facility. The monitoring relies primarily on a set of sixteen RCRA-compliant groundwater monitoring wells (Figure 3) installed over 1991-92 as part of a voluntary remedial investigation/feasibility study (RI/FS) conducted at the Framatome site. While only these wells are used for the collection of groundwater quality samples, a number of pre-existing wells installed between the early 1970's and late 1980's are used in addition to the newer wells for the measurement of groundwater elevations.

Results of the groundwater monitoring conducted as an extension of the site-wide RI/FS are reported to Ecology on a quarterly basis. Data from a subset of the wells most pertinent to monitoring of the surface impoundment operations are reported to Ecology in an annual RCRA Groundwater Quality Report.

Data from wells adjacent to and downgradient from the lagoons have indicated above background levels of ammonium, nitrates, fluorides, trichlorethylene (TCE), and radionuclides (gross alpha, gross beta). All but the TCE are constituents of the surface impoundment solutions and are thought to have reached the groundwater via historic lagoon liner leaks (1970's) and leaks from associated piping (1970's, 1980's) when certain of the lagoons were single-lined and much of the piping was single-walled and buried. (All lagoons have since been equipped with two or more liners and intervening leachate detection/collection systems and all single-walled underground lagoon piping has been removed from service). TCE, not a constituent of the lagoon solutions, may have been released during installation or repair of Hypalon lagoon liners, although there is no documentation or knowledge of such a release having occurred. Levels of these contaminants in the groundwater are generally decreasing, in the case of TCE and fluorides to concentrations at or below safe drinking water limits and for nitrates to levels at or below concentrations in groundwater upgradient of the facility.

2.2 *Physiographic Characterization*

This section describes the general physiographic characteristics of the area around the FANP facility.

2.2.1 General Physical Setting

The FANP property is located within the Pasco Basin, between the Yakima and Columbia Rivers. The topography of the FANP property and surrounding area is relatively flat; however, gentle north-south trending topographic ridges occur east and west of the property. The major topographic relief is found in the Cascade Mountains, 80 miles to the west.

2.2.2 Climate

In general, climatological conditions for the FANP area can be described as semiarid or desert-like, with the Hanford Meteorological Station (HMS) recording approximately 7 inches of average annual precipitation for the Hanford area. Although the most common form of precipitation is rain, snow falls regularly during winter; and, occasionally, hail falls during summer thunderstorms. In general, the precipitation is lowest in July, and greatest from October through February. Mean annual evapotranspiration is estimated to be equal to mean annual precipitation (7 inches).

Winters in the Hanford area are moderately cold; summers are hot and dry with ample sunshine. Average temperatures range from 23 degrees Fahrenheit (°F) to 100°F with historical temperature extremes at -20°F and 115°F (HMS data).

Typically, winds from the west-northwest to northwest predominate at the HMS, averaging 6 to 7 miles per hour (mph) in the winter and 8 to 10 mph in the summer. From March through August, a diurnal effect increases the afternoon and evening wind speeds by 4 to 6 mph. The strongest winds at the HMS area come from the southwest and usually occur at the highest frequency from March through May.

2.2.3 Surficial Soils

The major soil types in the vicinity of FANP include the Winchester sand and Winchester fine sand. The Winchester soils were derived from basalts and have a characteristic "salt and pepper" appearance. These soils also are characterized as having low moisture-retaining capacities.

The most common type of soil found in the FANP property vicinity, Winchester sand, is a dark-gray-to-almost-black, loose, medium-to-coarse sand with an average depth of 12 inches. The subsoil is dark-brownish-gray-to-nearly-black sand that overlies loose, black, coarse-grained sand at 3 to 5 feet. The Winchester sand surface is generally covered with a thin mantle of dark-colored coarse sand composed largely of small, rounded and subangular particles of basalt. The finer materials, containing basalt and quartz grains, are low in organic matter, well-drained, and easily drifted by wind. In some areas, basalt gravel occurs on the surface and within the first few upper inches of the soil (USDOE 1990).

The second most common soil type identified in the FANP vicinity, Winchester fine sand, is more extensive east and southeast of the FANP property, although one area was identified immediately adjacent to the west. The Winchester fine sand is fine-grained, dark-gray-to-brownish-gray, loose sand that occurs to a depth of approximately 12 inches. The subsoil is a dark-brownish-gray-to-grayish brown loose fine sand overlying sandy gravel at a depth of 3 feet or more. Both the surface soils and the subsoil are low in organic matter, porous, and unconsolidated. Gravel occurs on the surface and throughout the soil section (USDOE 1990).

2.2.4 Surface Water

The two major surface water bodies in the Pasco Basin and near the FANP property are the Columbia and Yakima Rivers. The Columbia River originates in the Canadian Rocky Mountains and flows southerly through Washington until it turns west along the Oregon/Washington border and empties into the Pacific Ocean. At its nearest point the Columbia passes approximately 1½ miles due east of FANP at the Hanford Reach. The Columbia River channel along the Hanford Reach averages 1,200 to 1,800 feet wide and 10 to 40 feet deep. Volumetric flow rates in the Columbia's Hanford Reach vary widely and erratically due to operations of the Priest Rapids Dam. Daily flow rates may range from 36,000 to 160,000 cubic feet per second (cfs) and are accompanied by fluctuations in river stage of about 5 feet (USDOE 1990).

The Yakima River, a major tributary of the Columbia and the third largest river in the Pasco Basin, flows southeasterly out of the Cascade Range in central Washington and joins the Columbia River southeast of Richland, in the southern portion of the Pasco Basin. The width of the Yakima River channel averages about 200 feet. Volumetric flow rates in the Yakima River range from 1,300 to 20,000 cfs. The Horn Rapids Dam, located about 9 miles northwest of the FANP facility, provides irrigation water to the surrounding agricultural areas (USDOE 1990).

2.2.5 Geology

The FANP facility is underlain by poorly and well graded sands and gravels of the Pasco gravels in the Hanford formation and also the Ringold Formation. The two stratigraphic units are differentiated by the basalt content and color of the sand and gravel fractions of borehole cuttings and soil samples (Pasco gravels tend to be basalt rich and dark gray in color while the upper portions of the Ringold Formation tend to be basalt poor and light yellow brown to tan color). The elevation of the contact between the Pasco gravels and the Ringold Formation varies from approximately 368 feet mean sea level (msl) to approximately 342 feet msl. The total thickness of the two formations ranges from approximately 30 to 45 feet (Geraghty & Miller 1993).

2.2.6 Hydrogeology

The hydrogeology beneath the FANP facility consists of four hydrostratigraphic units: a shallow vadose zone, an unconfined (water table) aquifer, a silt aquitard, and an underlying confined aquifer, as described below.

The vadose zone, which is defined as the unsaturated area between the land surface and the upper surface of the unconfined aquifer (water table), consists primarily of poorly to well-graded sands and gravels, and materials suspected to be fill. The thickness of the vadose zone varies with the topography of the facility and ranges from approximately 10 to 15 feet thick in the vicinity of the active facility (fenced area of the FANP property) to approximately 50 feet thick southwest of the active facility. Most of the vadose zone occurs within the Pasco gravels of the Hanford formation (Geraghty & Miller 1993).

The surface of the unconfined aquifer beneath the property occurs in both the Pasco Gravels and the Ringold Formation at depths ranging from approximately 10 to 50 feet below land surface (bls) and at elevations ranging from 354.5 to 355.5 feet msl. The water table is generally encountered at approximately 15 feet bls within the fenced portion of the FANP facility. The unconfined aquifer is approximately 20 feet thick with its lower boundary being the contact with a silt aquitard (Geraghty & Miller 1993).

A silt aquitard occurs beneath the FANP property at depths ranging from approximately 30 to 50 feet bls (332 to 340 feet msl). It is approximately 30 to 35 feet thick and separates the unconfined aquifer from the underlying confined aquifer (Geraghty & Miller 1993).

The confined aquifer occurs in sands and gravels of the Ringold Formation. The aquifer was encountered beneath the FANP facility and the HRL at similar elevations of approximately 305 feet msl (the base of the overlying aquitard). The confined aquifer sediments consist of interbedded sands and gravels. The confined aquifer appears to be laterally continuous but may be merged with the overlying unconfined aquifer near the Yakima and Columbia Rivers (Geraghty & Miller 1993).

3. **Closure Procedures for the Surface Impoundment System**

This Closure Plan is designed to provide a detailed plan for the closure of the surface impoundment system in a manner that will meet the closure objectives specified in Section 1.3 of this plan. Upon completion of this plan, the potential will exist for beneficial reuse of portions of the land now devoted to the surface impoundment waste management unit which have been cleared and cleaned of dangerous waste and dangerous waste constituents.

FANP plans to clean close the surface impoundments waste management unit in accordance with 40 CFR 265 Subpart G and 40 CFR 265.228(a)(1). The structural components of the surface impoundment system will be dismantled, decontaminated as appropriate to minimize waste and disposal volumes, and disposed of off-site at appropriate disposal facilities as described in Sections 3.5 and 3.6. Environmental media, i.e., soil underlying the impoundments and inter-liner sand, will be evaluated with respect to MTCA Method B unrestricted land use cleanup levels. Environmental media meeting those cleanup levels will be left in place (e.g., undisturbed soil below cleanup levels) or re-introduced as fill material (e.g., inter-liner sand and disturbed soil below cleanup levels). Environmental media not meeting cleanup levels will be decontaminated (washing/chemical extraction) or disposed of consistent with waste minimization/disposal volume reduction objectives. Should verification sampling of soil beneath the impoundments indicate that unexpectedly high volumes of soil have been impacted by releases from any of the surface impoundments, contingent closure and postclosure activities may be performed in accordance with 40 CFR 265.228(a)(2). However, sampling activities conducted to date and the nature of the hazardous constituents present (fate and transport characteristics and low toxicity), indicate that contingent closure activities are unlikely.

This section provides a detailed description of the closure activities to be implemented by FANP in completing the final closure. These activities are generally discussed in their anticipated sequence of implementation.

3.1 ***Preclosure Activities***

As discussed earlier in Sections 1.0 and 1.2, the scope of the closure activities covered by this plan includes processing of the remaining surface impoundment inventory (which includes recovery/recycling of uranium and ammonia), followed by physical remediation/closure of the impoundment structures themselves, including environmental media impacted above cleanup levels. Furthermore, as discussed in Section 1.1, both major phases of the closure effort, i.e., inventory processing/disposition and structural/environmental remediation, are subject to a schedule imposed under the 1996 FANP/Ecology consent decree agreement. That schedule is discussed further in Section 4.1.

The lagoon inventory processing and recycling facilities will continue to operate as the lagoons are emptied of their waste inventories. Some of the facilities will continue to be used after the lagoons are empty in conjunction with the soil washing equipment for lagoon subsoil and inter-liner sand decontamination and segregation. (Certain of the facilities may have processing/recycling missions after lagoon closure as well.) The physical closure of the lagoon structures will commence soon after the lagoons are empty. The inventory processing/reclamation phase of this closure plan is based on the maximum inventory that will be present in the lagoons between now and the time they are empty. The maximum inventory is conservatively considered to be the lagoon capacity for the currently utilized Lagoon 2 and the current inventory for the lagoons which no longer receive waste and are empty or being emptied, i.e., Lagoons 1, 3, 4, 5A, and 5B. The sand trench and leach pit are empty and no longer receive waste, having been replaced in function by the Solids Processing Facility described in Section 2.1.4.

3.1.1 Lagoon Inventory Removal and Treatment

As dictated by the consent decree schedule/milestones, the inventory processing (lagoon emptying) phase is already well along, utilizing a number of fully operational wastewater treatment/recycling facilities. Certain of these facilities were in operation prior to the consent decree, processing currently generated liquid effluents, and will have a continuing similar role after the lagoons are empty. The other facilities were constructed specifically for processing the legacy lagoon inventory and have no currently identified mission once the lagoons are empty. The lagoon inventory processing activities are discussed in more detail in Section 3.4.

3.1.2 Lagoon Closure Process Qualification

A key premise in the closure of the lagoons is that radioactive uranium contamination is also an indicator of chemical contamination. This premise is based on the fact that chemical and radioactive (uranium) contamination have occurred together, generally from a spill or leak of mixed waste lagoon solutions. It is also assumed that since the cleanup criteria for uranium contamination will be stricter (on a concentration basis) than cleanup criteria related to chemical salts present in the lagoons, soil cleaned to below uranium contamination limits will also be cleaned to below cleanup limits related to chemical salts. This is because the nitrate, fluoride, sulfate, and ammonium salts, which are the primary constituents of the chemical contamination, have a relatively low toxicity (and therefore relatively higher cleanup levels) and are readily soluble in water and will be removed at least as well as uranium contamination in soil washing or other aqueous cleanup processes. These premises will be tested during the qualification of lagoon sampling and decontamination processes which is currently being initiated now that Lagoon 3 is empty.

The purpose of the lagoon closure process qualification is to identify and qualify the lagoon closure processes using selected areas of Lagoon 3, the Sand Trench, and the Leach Pit. The qualification process involves: 1) identifying contaminated areas, 2) cleaning up selected areas of radioactive (uranium) and chemical contamination, and 3) verifying the effectiveness of this process. Verification samples will be analyzed for both uranium and pertinent chemical constituents. The viability of using radioactive contamination as an indicator for chemical contamination will be evaluated and verified through analysis of the sample data.

As part of the lagoon closure process qualification, the effectiveness of soil washing for uranium and chemical decontamination was verified using bench-scale equipment. Accordingly, soil washing equipment has been purchased to treat contaminated soil and inter-liner sand that is removed during lagoon closure operations. The soil washing process will also utilize some existing processing equipment, including pumps, piping, tanks, and filter presses.

3.1.3 Installation of Lagoon Replacement Systems

A second pre-requisite to removal of the lagoons from service (in addition to inventory processing) is the installation of tank systems and associated wastewater treatment/ recycling systems required to replace the surface impoundments. This work is also well underway, with most of the systems already installed and the remainder undergoing installation. The first of the tanks required to replace the surface impoundments, i.e., the Lagoon 5A replacement tank, was placed into operation in August 2003. The two tanks replacing Lagoons 1 and 2 are slated for startup in December 2003. Replacement tanks will not be required for Lagoons 3, 4, and 5B.

3.1.4 Regulatory Permitting

Facilities currently involved in processing/reclamation of the surface impoundment inventory have been previously authorized under U.S. Nuclear Regulatory Commission (NRC) and Ecology regulatory frameworks. Lagoon replacement tanks and associated systems have been approved under Ecology's industrial wastewater facility construction approval process (WAC 173-240) and are currently licensed, or undergoing licensing, under U.S. Nuclear Regulatory Commission (NRC) requirements. Remediation and/or removal of surface impoundment structures and impacted environmental media will proceed in accordance with an Ecology-approved interim status closure plan and in accordance with NRC requirements.

3.1.5 Establishment of MTCA Cleanup Levels

As previously stated in Sections 1.2, "General Closure Approach," and 1.3 "Closure Objectives," the intent of this closure action is to close the surface impoundment system to MTCA Method B cleanup levels. Accordingly, MTCA Method B cleanup levels have been developed for six constituents of concern (COC's) applicable to environmental media underlying, and in the vicinity of, the surface impoundments. These COC's were selected based on their presence in the surface impoundment liquids and sludges and/or their identification as environmental COC's by FANP's earlier site remedial investigation/feasibility study (RI/FS) and associated groundwater monitoring program.

3.1.5.1 Identification of Constituents of Concern (COC's)

Information characterizing the contents of the liquids and solids in (or formerly in) the surface impoundments is provided in the Waste Data Table (Attachment B) of FANP's current approved Waste Analysis Plan (EMF-2510, Revision 2). Pertinent data relating to waste designation codes and associated chemical constituents have been extracted from the Waste Data Table and included herein as Table 1. As indicated by Table 1, the lagoon contents designate as dangerous wastes due to state-only toxicity (WT02) related primarily to salts of ammonia, nitrate, fluoride, and sulfate and due to F002 and F003 (state only) listings related to low concentrations of Freon 113 and acetone, respectively. Since the primary source of environmental contamination associated with the surface impoundment system is the historic leakage of lagoon solutions from certain lagoons that were initially single-lined, Table 1 data serve as a key basis for the selection of environmental COC's.

Based on consideration of the Table 1 information, fluoride, nitrate, uranium, acetone, and 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113) have been selected as COC's. Fluoride and nitrate are the optimal non-radiological COC's due to their prevalence in the lagoon inventories, currently and historically; their presence in the chemical compounds (ammonium fluoride, ammonium nitrate) responsible for the WT02 state-only toxicity designation of the lagoon contents; and the fact that applicable MTCA Method B cleanup levels have been established.

With respect to radiological constituents, uranium is the feed material to the plant's entire fuel fabrication process and as such is the radionuclide of concern in all its liquid, gaseous, and solid waste effluents. As in the case of fluorides and nitrates, applicable MTCA Method B cleanup levels for uranium have been established or are derivable using available data. Fluoride, nitrate, and uranium have been detected at levels exceeding background via FANP's ongoing groundwater monitoring program.

As indicated by Table 1, the lagoons carry F002 and F003 listings due to low concentrations of Freon 113 and acetone (<0.025 ppm and <0.2 ppm, respectively) detected in a very limited number of lagoon liquid and solids samples collected in 1992/93, prior to the plant's initiative to totally eliminate all solvent discharges (e.g., certain analytical laboratory wastes) to the surface impoundments. Based on their minimal prevalence and concentrations within the lagoons, Freon 113 and acetone are not expected to be present in environmental media at levels approaching the applicable MTCA cleanup levels. Sampling for these COC's will be reserved until the final confirmation survey which includes verification sampling on washed environmental media, and then at a reduced sampling frequency when compared to the primary COC's, i.e., uranium, fluoride, and nitrates. The data will document compliance of the remediated surface impoundment area with cleanup levels and will also serve as the basis for a contained-in determination which will be submitted to Ecology for the removal of the F002 and F003 listed waste codes from sand and soil (removed/washed) being returned to the remediated surface impoundment area.

The final COC is trichloroethylene (TCE), which was detected only in the solids from a single lagoon (Lagoon 3), and then at trace levels (<0.025 ppm). The most likely source of the TCE, i.e., residues from adhesive used to bond seams in the Lagoon 3 Hypalon liners, would not qualify as a regulated hazardous waste or necessitate an associated F-code listing. TCE has however been detected at low concentrations in groundwater, both during the original RI/FS as well as in subsequent groundwater monitoring. The source of TCE in groundwater below the lagoons is not known. TCE has not been used as a major process or maintenance-related chemical at the Richland plant and is not a current, or known historic, component of any liquid effluent at the plant, lagoon-bound or otherwise. Although TCE was utilized by outside construction forces and FANP personnel involved in historic lagoon liner installation activities, no instances of environmental releases of TCE were reported.

The concentrations of TCE measured in the groundwater have been very low – less than 100 ppb even in initial groundwater monitoring supporting the site RI/FS (1991-92). Such levels are not consistent with a soil source of TCE. Furthermore, groundwater concentrations have diminished to levels at or below the 5 ppb EPA safe drinking water standard for TCE. Sampling for TCE will be conducted as part of the final confirmation survey, in conjunction with sampling for acetone and Freon 113, to confirm that the remediated surface impoundment area meets TCE cleanup levels.

3.1.5.2 Development of Cleanup Levels

Method B cleanup levels for the six COC's discussed above have been developed in accordance with the requirements of WAC 173-340 Part VII. The development of the cleanup levels is documented in Appendix A, Development of MTCA Cleanup Levels. The specific cleanup levels are provided below.

Constituent of Concern	Soil Cleanup Level	Groundwater Cleanup Level
Soluble Fluoride	4,800 mg/kg	960 ug/L
Nitrate (as N)	8,000 mg/kg	1,600 ug/L
Uranium, Soluble Salts	17.7 mg/kg*	30 ug/L
Acetone	10.4 mg/kg	800 ug/L
Freon 113	68,000 mg/kg	480,000 ug/L
Trichloroethylene	0.11 mg/kg	5 ug/L

* At a uranium U-235 enrichment of 3.5%, this translates to an activity level of 42 pCi/g.

3.1.6 Establishment of Relevant Points of Compliance

The surface impoundment system, as described in Section 3.2, includes six impoundments, the sand trench, and the leach pit. It is the intention of this closure plan to meet established clean closure levels throughout the area underlying the surface impoundment system. Therefore, the relevant point of compliance for soil will be those areas underlying what is considered the surface impoundment system. As described in Section 2.1.6, Framatome monitors groundwater throughout the Richland facility, with several of the wells located downgradient of the lagoon system. The nearest downgradient monitoring wells, i.e., GM-5, GM-6, GM-7, GM-8, and GM-16, will serve as the relevant point of compliance for groundwater.

3.1.7 Compliance Monitoring

Programs are defined, and to a significant extent already in operation, to address the compliance monitoring requirements of WAC 173-340-410, namely protection monitoring, performance monitoring, and confirmational monitoring.

With respect to protection monitoring, the ongoing lagoon inventory removal/processing operations and soon-to-follow lagoon structure removal and environmental remediation operations, are subject to the full application of FANP's existing health, safety, and environmental programs. The work is being performed by FANP personnel who are fully trained in the health and safety aspects of working at the surface impoundments and in the hazards associated with the chemical and radiological constituents present in the lagoon solutions and sludges. Worker health protection monitoring activities include breathing zone sampling for radioactive and non-radioactive particulates, radiological bioassay programs (urine analysis and in-vivo counting), and company-provided physicals. Ongoing environmental surveillance programs include ambient air monitoring and soil sampling for radioactive constituents, and groundwater sampling for radioactive and chemical constituents. FANP's worker and environmental protection programs are defined in FANP's Safety Manual (EMF-30) and sub-tier implementing procedures.

Performance monitoring, i.e., confirmation that the cleanup action attains cleanup standards, is the subject of this closure plan. Applicable cleanup limits are set forth in Section 3.1.5.2 of the Plan. Methodologies to address the removal/remediation/verification of containment systems and environmental media to meet those cleanup limits are set forth in Sections 3.5 and 3.7 of the Plan, along with its associated Sampling and Analysis Plan (Appendix B).

Confirmational monitoring, i.e., confirmation of the long-term effectiveness of the cleanup action, will be met by FANP's ongoing groundwater monitoring program. As indicated in Section 3.10 of the Plan, this monitoring will be continued for a minimum of two years following completion of the cleanup action. The program is based on a sampling and analysis plan on-file with Ecology; monitoring results are submitted to Ecology on a quarterly basis. Ultimate comparisons of monitoring data to groundwater cleanup limits upon completion of the cleanup action will utilize data analysis/evaluation procedures consistent with WAC 173-340-720(9).

3.2 *Waste Management Unit Description Summary*

The waste management unit addressed in this Closure Plan consists of six surface impoundments: Lagoons 1, 2, 3, 4, 5A, and 5B (Figure 2). The cleanup will also include ancillary equipment and facilities, including buried pipe and two temporary holding areas, the sand trench and leach pit. The physical data for the surface impoundments are tabulated in Table 2. Information regarding the physical configuration and operating history of each of the surface impoundments is presented below. The physical dimensions and operating histories of the impoundments were compiled from existing sources and Framatome records.

3.2.1 Lagoon 1

The physical characteristics of Lagoon 1 are outlined in Table 2. Lagoon 1 was constructed in 1971 with a single Petromat™ liner installed atop a 6-inch layer of compacted sand. Petromat™ is a nonwoven polypropylene cloth coated with asbestos-impregnated asphalt. In 1973, the Petromat™ liner was resurfaced with a second coat of asphalt and asbestos. Lagoon 1 was relined in 1979 using a "sandwich" construction consisting of six inches of sand separating a lower 36-mil (or 0.036-inch) thick Hypalon™ liner and an upper 45-mil (0.045-inch) thick Hypalon™ liner. The new liners were installed directly over the original Petromat™ liner. In 1992, Lagoon 1 was again relined using two 60-mil thick high density polyethylene (HDPE) liners with intervening GEONET™ drainage and leak detection. Lagoon 1 also has an HDPE cover to contain ammonia fumes. The original Petromat™ and Hypalon™ liners were not removed prior to installation of the HDPE liners. Grading for Lagoon 1 involved cutting to obtain the final grades. The surrounding berms were predominantly constructed through filling. Plate 1 presents current as-built specifications for Lagoon 1.

3.2.2 Lagoon 2

The physical characteristics of Lagoon 2 are outlined in Table 2. Lagoon 2 was placed into service at the beginning of facility operations in October 1971 with a single Petromat™ liner installed atop a 6-inch layer of compacted sand. Lagoon 2 was relined in 1978 using a "sandwich" construction consisting of a leak detection system installed in six inches of sand separating a lower 36-mil (or 0.036-inch) thick Hypalon™ liner and an upper 45-mil (0.045-inch) thick Hypalon™ liner. The new liners were installed directly over the original Petromat™ liner. In 1989, a 60-mil thick HDPE liner was installed directly over the Hypalon™ liners. Lagoon 2 also has a 60-mil thick HDPE cover to contain ammonia fumes. Plate 2 presents current as-built specifications for Lagoon 2.

Grading for Lagoon 2 involved cutting to obtain the final grades. The surrounding berms were predominantly constructed through filling. The exterior slopes of the berms are surfaced with 4 inches of 4-inch minus gravel.

3.2.3 Lagoon 3

The physical characteristics of Lagoon 3 are outlined in Table 2. Lagoon 3 was constructed in 1974 with a single Petromat™ liner installed atop a 6-inch layer of compacted sand. In 1979 the two Hypalon™ liners were installed in a "sandwich" construction consisting of a ten-inch layer of sand separating the lower 36-mil thick liner and the upper 45-mil thick liner. The new liners were installed directly over the original Petromat™ liner. A leak detection system was also installed in the sand layer between the two liners. There is no record of repairs made to Lagoon 3 during its operating history. Plate 3 presents current as-built specifications for Lagoon 3.

Grading for Lagoon 3 involved both cutting and filling to obtain the final grades. The exterior slopes of the berms are surfaced with 4 inches of 4-inch minus gravel. Splash shields are provided along the northeast corner of the impoundment to prevent waves from overtopping the impoundment berms.

3.2.4 Lagoon 4

The physical characteristics of Lagoon 4 are outlined in Table 2. Lagoon 4 was constructed in 1979 with a "sandwich" construction consisting of two liners made of Hypalon™ material with approximately four inches of sand separating each liner. The lower liner is 36-mil thick Hypalon™, while the upper liner is 45-mil thick Hypalon™. A leak detection system was installed in the sand layer between the two liners. Three lateral drain field pipes were installed beneath Lagoon 4 to serve as catch basins. The drains, oriented east-west, terminate in dry caissons and provide for leak detection and testing of the lower Hypalon™ liner. In 1989, an 80-mil thick HDPE liner was installed over the original Hypalon™ liners. There is no record of repairs made to Lagoon 4 during its operating history. Plate 4 presents current as-built specifications for Lagoon 4.

Grading for Lagoon 4 involved both cutting and filling to obtain the final grades. The exterior slopes of the berms are surfaced with 2 inches of 3/4-inch minus crushed rock. Splash shields are provided along the northeast corner of the impoundment to prevent waves from overtopping the impoundment berms.

3.2.5 Lagoon 5A

The physical characteristics of Lagoon 5A are outlined in Table 2. Lagoon 5A was constructed in 1982 with a single 36-mil thick Hypalon™ liner. An approximately 12-foot deep trench underlying the south edge of the impoundment served as a catch basin. In 1983, a 45-mil thick Hypalon™ liner was placed over four inches of sand with leak detection installed above the original Hypalon™ liner. The upper Hypalon™ liner was repaired in 1988. Plate 5 presents current as-built specifications for Lagoon 5A.

Grading for Lagoon 5A involved both cutting and filling to obtain the final grades. The exterior slopes of the berms are surfaced with 2 inches of 3/4-inch minus crushed rock. Splash shields are provided along the northeast corner of the impoundment to prevent waves from overtopping the impoundment berms.

3.2.6 Lagoon 5B

The physical characteristics of Lagoon 5B are outlined in Table 2. Lagoon 5B was constructed in 1983 with a "sandwich" construction consisting of a lower 36-mil thick Hypalon™ and an upper 45-mil thick Hypalon™ liner with approximately four inches of sand separating the liners. A PVC leak detection system was installed between the two liners during initial construction. The upper Hypalon™ liner was repaired in 1988. Plate 6 presents current as-built specifications for Lagoon 5B.

Grading for Lagoon 5B involved primarily cutting to obtain the final grades. The surrounding berms were constructed with interior side slope angles of 3 horizontal to 1 vertical (3H:1V). The exterior slopes of the berms are surfaced with 2 inches of one and 1/4-inch minus crushed rock. Splash shields are provided along the northeast corner of the impoundment to prevent waves from overtopping the impoundment berms.

3.2.7 Lagoon Ancillary Equipment

Ancillary equipment associated with the surface impoundments include: the liners as mentioned in Sections 3.2.1 through 3.2.6; the bolts, nuts, washers, rebar, and concrete used to anchor the liners; splash guards, and the pumps and PVC piping used to transfer solutions throughout the plant. Approximately 3400 feet of buried transfer pipe is associated with the lagoon system.

3.2.8 Sand Trench and Leach Pit

Two temporary surface impoundments (Sand Trench and Leach Pit) were installed to facilitate previous lagoon clean-outs and liner replacements. They are not currently in service.

The sand trench was constructed in 1977 with a single Hypalon™ liner. It is approximately 300 feet long and 39 feet wide by 6 feet deep. The trench was used to hold wind-blown sand from Lagoons 1 and 2 during lagoon cleaning and when the liners were replaced in 1980 and 1988. The sand has been removed and the trench is no longer in service. The trench may be utilized on an interim basis in the near-term to provide temporary storage of sand/soil during lagoon remediation.

The leach pit was constructed in 1983 with double Hypalon liners and inter-liner leak detection. Two additional Hypalon liners were added in 1987. A fifth liner of HDPE was added in 1990. The leach pit is approximately 50 feet by 40 feet and 8.5 feet deep. The leach pit contained washed sand from Lagoons 1 and 2 and was used briefly to test uranium recovery using ammonium carbonate solution. The sand has been removed and the leach pit is no longer in service.

3.3 *Maximum Waste Inventory*

Based on the full working volumes of the six surface impoundments (see Table 2), the maximum historic volume of liquids/solids that could be stored within the system was approximately 9.6 million gallons. However in light of the consent decree milestone for emptying the lagoons (Section 4.1), the inventory in the lagoons has been worked down to approximately 1.65 million gallons. Only Lagoon 2 is actively receiving currently generated production liquid effluents and Lagoon 5B is the only remaining lagoon with substantial quantities of legacy liquids and solids. Lagoons 1, 3, and 4 are empty; Lagoon 5A contains a relatively small volume of residual solids and liquids. Maximum surface impoundment inventory at this point in time is conservatively calculated as the full working capacity of Lagoon 2 plus the current inventories of Lagoons 5A and 5B, as follows:

Lagoon 1 – Empty

Lagoon 2 – 0.7 M gallons (full capacity)

Lagoon 3 – Empty

Lagoon 4 – Empty

Lagoon 5A – 0.05 M gallons

Lagoon 5B – 0.8 M gallons as stored (1.3 M gallons after recovery process dilution)

TOTAL – 1.55 M gallons (2.05 M gallons after Lagoon 5B dilution)

The processes being utilized to remove and process this inventory are discussed in Section 3.4.

3.4 *Lagoon Inventory Removal and Treatment*

Removal of the lagoon inventory (liquids and solids) from the lagoons is required to be completed by September 2004 in compliance with the FANP/Ecology consent decree schedule. Equipment and facilities are currently in operation that remove and process the lagoon solids and liquids. The facilities recover uranium and ammonia for recycle or sale. Lagoon solids are removed via a dredging system and liquids are removed via in-place piping and pumps. The inventory work-off has involved the operation of four key wastewater treatment and recycling facilities described below.

In the Solids Processing Facility (SPF), uranium is leached from the lagoon solids and dissolved in an aqueous solution. The uranium contained in the lagoon liquids and SPF uranium solution is then recovered in the Lagoon Uranium Recovery (LUR) process. The uranium is recovered as a solid and is subsequently purified and recycled back into the fuel fabrication process. The residual lagoon solids from the SPF are sent to Envirocare of Utah for disposal.

A Silica Removal Process (SRP) was installed in 1999 to remove excess silica from the lagoon solutions from SPF and LUR to reduce silica fouling of Ammonia Recovery Facility (ARF) heat exchangers and improve ARF operation. The SRP can also treat lagoon solutions and soil washing wastewaters that have not been processed for uranium removal at SPF/LUR prior to silicon removal. The residual lagoon silica solids from SRP are sent to Envirocare of Utah for disposal.

Ammonia is recovered from the lagoon liquids in ARF after they are treated at SRP to reduce dissolved silica. (Currently generated ammonia-bearing solutions from Lagoon 2 do not require silica removal.) Ammonia is recycled back into the fuel fabrication process or sold as fertilizer. Following ammonia removal at ARF, the lagoon liquids pass through a final ion exchange system to remove trace uranium before being discharged to the City of Richland wastewater treatment plant. The recovered uranium from the ion exchange process is also recycled back into the fuel fabrication process.

3.5 *Containment Systems Closure*

The following sections address methods for closing the surface impoundment containment systems. Containment system components include the following: Petromat™, Hypalon™, and high density polyethylene (HDPE) liners; the sand layers between liners; splash shields; solution transfer piping; and the rebar, concrete, and hardware anchoring the liners. Removal of the surface impoundment containment structures will generate a number of waste streams, which along with wastes generated in the subsequent environmental remediation activities, are summarized in Table 3. As discussed in more detail below, all of the above containment system components with the exception of inter-liner sand will be dispositioned under protocols for hazardous debris; inter-liner sand will be dispositioned as environmental media.

The liners, compacted sand layers, and associated component systems will be removed in sequence from the top of each unit to the base. Prior to removal, the surface of each liner will be visually inspected for cracks or other openings through which washing fluid may reach underlying soil. Care will be taken during the liner removal process to ensure that any subsequent underlying liners are not damaged or disturbed during the removal process, so as to allow for uncompromised inspection of the underlying liners. A record will be maintained, as part of a field notebook, of all openings (cracks, holes, etc.)

identified. This record will consist of documentation identifying and describing the location and dimensions of identified openings. The record will be used to bias characterization sampling of environmental media toward locations where contamination of environmental media is most likely.

3.5.1 Disposition of Hazardous Debris

With the exception of the inter-liner sands, the lagoon containment systems discussed below will meet the regulatory definition of debris, i.e., solid material which exceeds 60 mm (2.5 inches) particle size and is intended for disposal. The debris, which includes liners, piping, concrete, and other ancillary construction components, will have been in direct contact, or in potential contact, with lagoon solutions which in all cases designate as dangerous per Ecology Dangerous Waste Regulations (see Section 3.1.5.1). Consistent with FANP objectives for waste minimization/disposal volume reduction, certain debris amenable to release will be treated using appropriate technologies listed in 40 CFR 268.45 Table 1 to allow for its release from dangerous waste management requirements, provided it meets the associated performance/operating standard. FANP intends on using one or more of the following treatment technologies as applicable. Debris so treated and meeting the associated performance standard will be considered released from dangerous waste management requirements.

40 CFR 268.45 Table 1 Technology Description	Application	Performance Standard
Abrasive blasting (A.1.a)	Plastic and metal debris	Treatment to a clean debris surface (as defined in 40 CFR 268.45 Table 1)
	Concrete, pavement, brick, rock	Treatment to clean debris surface and removal of at least 0.6 cm of surface layer
High pressure steam and water sprays (A.1.e)	Plastic and metal debris, liner materials	Treatment to a clean debris surface
	Concrete, pavement, rock, brick	Treatment to a clean debris surface and removal of at least 0.6 cm of surface layer
Water washing and spraying (A.2.a)	Plastic and metal debris, liner materials	Treatment to a clean debris surface
	Concrete, brick, pavement, rock (max. 1.2 cm in one dimension)	Treatment to clean debris surface; contaminant must be soluble to at least 5% by wt. in water solution or 5% by wt. in emulsion. Contact of debris surface with water for at least 15 minutes.

In reality, the materials slated for decontamination efforts are very limited in scope, namely HDPE liner material and concrete anchors from the lagoon periphery. All other liner materials, piping, and ancillary equipment are envisioned for direct disposal due to expected difficulties in achieving and/or demonstrating effective radiological and chemical decontamination.

The application of the alternative treatment methodologies for hazardous debris will generate either liquid or solid waste streams (see Table 3), dependent upon the method. Water sprays in conjunction with water/detergent washing and follow-up wiping/mopping will be utilized for the HDPE liners. Water usage will be very limited and removed via a combination of wiping/evaporation. Steam cleaning may also be used for some hazardous debris decontamination activities but no significant usage of this methodology is foreseen. Both treatment activities will take place in a low area of the lagoons with a contiguous liner in place which will be bermed to ensure that excess liquid is confined and collected in that particular area. Any excess liquid generated will be managed in the bermed area of the lagoon and allowed to evaporate, or, if necessary be pumped via existing lagoon piping into FANP's wastewater treatment system for disposal, either directly or via a portable transfer tank.

Abrasive blasting of debris, if necessary, will occur in an area of the lagoon system which will allow for the collection of the abrasive media. The only application foreseen for abrasive blasting is its possible usage to decontaminate concrete anchors located below the liners atop the lagoon berms. These anchors may be lightly contaminated, if at all, and the amount of abrasive blasting is foreseen to be limited in scope and duration. The media will be collected and appropriately managed after radiological screening. No additional disposal liability will be associated with the blasting media as it can be easily accommodated within the void spaces of ancillary equipment disposal boxes.

3.5.1.1 HDPE Liners

HDPE liners will be cut into manageable pieces, inspected for chemical contamination and surveyed for radiological contamination. Based on consideration of factors such as waste minimization, disposal volume limitation, and potential for effective radiological decontamination, the liner material may be subjected to one of the decontamination technologies discussed in Section 3.5.1. If the material then meets the associated performance standard, the material will be considered as released from further dangerous waste management requirements. Disposal will then be dictated solely based on residual radioactive contamination levels. Any decontamination activity performed on the liner will take place in the lagoon area. Final disposition of the HDPE liners, after applicable treatment has been performed, is expected to be at a permitted Subtitle D landfill such as the Roosevelt Landfill at Roosevelt, Washington. This is based on the expectation that decontamination efforts will be successful in achieving both chemical and radiological release limits.

3.5.1.2 Hypalon™ Liners

Hypalon™ liners are expected to be radiologically and chemically contaminated and not amenable to decontamination. The Hypalon™ liners will be cut into manageable pieces, sampled or surveyed to estimate uranium content, rolled up, and directly packaged into appropriate containers for disposal at Envirocare of Utah. Disposal containers, when full, will either be directly shipped offsite or temporarily stored onsite at the Dangerous Waste Storage Facility pending offsite shipment.

3.5.1.3 Petromat™ Liners

Petromat™ liners are expected to be radiologically and chemically contaminated and not amenable to decontamination. Furthermore, the matrix forming the Petromat contains asbestos, encapsulated within an asphalt-base material. For removal of the Petromat, appropriate FANP personnel have been trained to Washington Department of Labor and Industries requirements for asbestos supervisors and workers.

Alternatively, an appropriately certified asbestos remediation contractor will be used. Contact has also been made with the Benton Clean Air Authority (BCAA) relative to regulation of the Petromat removal under BCAA regulations. Based on the non-friable nature and ease of removal of the Petromat material, the Petromat removal is unlikely to require registration/regulation by the BCAA. This will be conclusively resolved prior to initiation of the Petromat removal. Acceptability of the Petromat for disposal as a mixed waste at the Envirocare disposal site has been confirmed via direct communication with the site operator.

The Petromat™ will be cut into manageable pieces, sampled or surveyed to estimate uranium content, and directly packaged into appropriate containers for disposal at Envirocare of Utah. Disposal containers, when full, will either be directly shipped offsite or temporarily stored at the onsite Dangerous Waste Storage Facility pending offsite shipment.

3.5.1.4 Ancillary Components

Concrete, rebar, PVC pipe, and compacted sand layers separating and underlying the liners will be excavated and removed by hand or using standard construction equipment. The concrete, metal, and plastic components will be considered for potential chemical decontamination based on concurrent consideration of waste minimization, disposal volume limitation, and radiological decontamination issues. As appropriate, release of this debris from dangerous waste management requirements will be pursued via the cleaning and inspection protocols of Section 3.5.1. Excavated PVC transfer piping, leak detection tubing, and other components with enclosed areas that are difficult to survey and verify clean will be cut into lengths shorter than 8 feet and packed for disposal as mixed waste at Envirocare of Utah. Disposition of inter-liner sand is discussed below in Section 3.5.2.

3.5.2 Disposition of Inter-liner Sand

The sand layers between the lagoon liners will not meet the regulatory definition of debris and, as previously stated, will be handled as environmental media. Certain of the sand layers are known to have contacted lagoon solutions as a result of known upper liner leaks in at least some of the lagoons. As such, the inter-liner sands have the potential for contamination with the dangerous waste constituents discussed in Section 3.1.5.1.

After the liners covering the compacted sand layers have been removed, the sand will be visually inspected and surveyed using gamma energy assay equipment for areas of contamination. As previously discussed in Section 3.1.2, radiological (uranium) contamination is expected to be a valid and conservative indicator of chemical contamination. Areas underlying cracks or holes identified in the upper liners will receive special attention. The sand layers separating and underlying the liners will be excavated and removed by hand or using standard construction equipment. Contaminated and potentially contaminated sand will be removed first and segregated for later soil washing. A conservative assumption has been made that 50 percent of the inter-liner sands in all six lagoons are contaminated chemically and/or radiologically to an extent requiring remediation. This translates to a total of approximately 65,000 ft^3 of sand requiring washing (approximately 11,500 ft^3, 7,000 ft^3, 30,500 ft^3, 8,000 ft^3, 4,000 ft^3, and 4,000 ft^3 from Lagoons 1, 2, 3, 4, 5A and 5B, respectively.) Washed sand will be returned to the site as fill provided it meets the cleanup levels for soil outlined in Section 3.1.5.2. This will be confirmed by a combination of radiological screening analyses backed by laboratory chemical constituent testing. This will be verified prior to return of the sand as fill, and only after the lagoon area receiving the sand has also been verified to meet cleanup levels.

Clean sand, i.e., sand not requiring soil washing, will also be removed and ultimately returned to the site as fill. As in the case of washed sand, the clean sand and the lagoon area receiving the sand will be required to meet the cleanup levels for soil outlined in Section 3.1.5.2; a combination of radiological instrumental analyses and laboratory chemical tests will be used to verify suitability of this sand for return as fill. As discussed in Section 3.1.5.1, final verification data on the sands relative to Freon 113 and acetone will be submitted to Ecology as the basis of a contained-in determination for the removal of the F002 and F003 waste codes from this environmental media.

Wastes associated with removal and remediation of the inter-liner sands are summarized, along with other wastes related to the impoundment structures, in Table 3.

3.6 *Containment Systems Packaging and Disposal*

Framatome will utilize a combination of field survey and visual inspection techniques to characterize the contamination on liner materials and ancillary components. Since none of these materials are being considered for retention onsite, they will be removed from the surface impoundments, containerized, and transported off-site for disposal. Decontaminated liners, rebar, concrete, and PVC pipe will be removed and containerized in 96-cubic foot steel burial boxes, large “roll-off” containers, or other appropriate disposal containers. Disposition of the decontaminated materials will depend on the presence and type of contamination. Mixed waste will be transported to Envirocare of Utah for disposal. Radiologically-only contaminated material will be disposed at US Ecology in Washington. Hazardous and potentially hazardous waste will be disposed at Chemical Waste Management, Arlington, Oregon site. Non-hazardous solid waste will be disposed at a permitted Subtitle D solid waste landfill (e.g., Roosevelt Landfill at Roosevelt, Washington). As previously discussed, any containment system components that have been in contact with dangerous wastes will only be released from dangerous waste management requirements if they have been demonstrated to meet the cleaning and release protocols of Section 3.5.1.

3.7 ***Soil Sampling, Removal and Treatment***

Framatome will utilize a combination of field survey (Gamma Energy Analysis, GEA) and discrete sampling and laboratory analyses to characterize the contamination in the soils beneath the surface impoundment liners. In survey units where contamination is found at levels exceeding the soil cleanup limits set forth in Section 3.1.5.2, the contaminated and potentially contaminated soil will be removed and soil washed to segregate the finer-size-fraction material, containing the bulk of the contamination, from the larger-size-fraction material. The washing process will also remove contamination adhering to larger particles. The soil washing process is described in greater detail in Section 3.7.3.

Soil, either undisturbed or after soil washing, confirmed to meet soil cleanup levels using analytical methodology outlined in Appendix B, “Sampling and Analysis Plan”, to this closure plan, will be considered suitable to be left in-place or returned as fill in support of clean closure objectives.

Wastes associated with remediation of the soil below the surface impoundments are summarized in Table 3, along with those wastes generated by the removal of the surface impoundment structures.

3.7.1 Characterization Survey

The floors and walls of the surface impoundments will be divided into survey units of a size to accommodate the sensitivity of the GEA with respect to the uranium cleanup level. The sampling plan and survey areas will be adjusted as necessary for presence of any holes or tears in the liner recorded in the earlier liner removal process. Each unit will be surveyed with the GEA and surface and subsurface soil samples will be taken from selected units. The lagoon closure qualification testing (Section 3.1.2) will help determine the size of the survey units and the correlation between GEA and discrete samples needed to assure detection of uranium and non-radiological chemical contamination to below the cleanup levels set forth in Section 3.1.5.2. Soil samples taken from the survey units will be analyzed for the presence of the primary COC’s (uranium, fluorides, and nitrates) as shown in the SAP. As discussed in Section 3.1.5.1, sampling and analysis for the organic COC’s (acetone, TCE, and Freon 113) will be reserved until the final confirmation survey, with the Freon 113 and acetone data being submitted to Ecology in support of a contained-in determination for the F002 and F003 waste codes. A soil fixative, tarps, or other dust control measures may be used to prevent airborne release of contamination during surveys and soil removal.

3.7.2 Subsoil Survey and Removal

Contaminated soil will be removed from survey units where the GEA survey and/or soil sampling and analysis show the presence of radiological and/or chemical contamination above pertinent cleanup levels. The contaminated and potentially contaminated soil will be segregated for soil washing. Heavily contaminated (i.e., relatively high radiological content) soils may be packaged for direct disposal. GEA surveys and/or soil samples will be used during soil removal to assure that contaminated soil has been removed. Work crews will use an iterative process of surveying and removing contaminated soil and resurveying until the unit meets cleanup criteria. Soil meeting cleanup criteria will be left in place. Manual removal will be used where subsurface soil contamination is localized. A backhoe or mechanical loader may be used to remove larger volumes.

Due to lack of access, thorough characterization of the subsoils beneath the surface impoundments has not been conducted. In 1978, prior to installation of double Hypalon™ liners, 80 subsoil samples were collected from four locations at varying depths beneath Lagoon 1 and analyzed for uranium. Three of the locations were suspected to have been impacted by surface impoundment operations via historic leaks in the original Petromat™ liner. The results of these analyses indicated that concentrations of uranium in five of the 80 samples (6 percent) were above 30 pCi/gm. Although not an environmental cleanup limit, 30 pCi/gm is a contamination limit in FANP's current NRC license, above which solid materials destined for offsite disposal would be required to be sent to a licensed disposal facility. While analyses for other surface impoundment inventory constituents were not performed, the uranium concentrations are assumed to be indicative of the presence of the other constituents. Based on these results and the fact that Lagoon 1 has been double lined with either Hypalon™ or HDPE liners since the sampling event, it has been conservatively estimated that six percent of the unsaturated subsoils beneath Lagoon 1 have been impacted to a degree necessitating remediation. Because Lagoons 2 and 3 have had operational histories similar to Lagoon 1, i.e., operation for several years with a single liner, six percent of the subsoils beneath Lagoons 2 and 3 have also been assumed to have been impacted to a degree requiring remediation. Lagoons 4, 5A, and 5B have had either double Hypalon™ or HDPE liners since being put into operation. Based on the dates, materials, and methods of construction, and leachate collection systems monitoring, it is assumed that none of the subsoils beneath Lagoons 4, 5A, and 5B are contaminated to an extent requiring remediation. It should be noted that utilization of the 30 pCi/g NRC license condition regulating offsite disposal of solids as the basis of this environmental cleanup assessment has proven to be conservative with respect to the 42 pCi/g uranium soil cleanup level ultimately derived (see Section 3.1.5.2 and Appendix A).

Based on this conservative estimate of the amount of soil potentially exceeding Ecology soil cleanup levels, the amount of soil utilized as the planning basis for the soil washing campaign (aqueous and chemical washing) is as follows:

Lagoon 1 – 35,000 ft^3 (top 6 inches of berm soil plus 6% of sub-liner soil to groundwater)

Lagoon 2 – 21,000 ft^3 (top 6 inches of berm soil plus 6% of sub-liner soil to groundwater)

Lagoon 3 – 47,000 ft^3 (top 6 inches of berm soil plus 6% of sub-liner soil to groundwater)

Lagoon 4 – 2,500 ft^3 (top 6 inches of berm soil)

Lagoon 5A – 2,000 ft^3 (top 6 inches of berm soil)

Lagoon 5B – 2,000 ft^3 (top 6 inches of berm soil)

Sand Trench – 16,000 ft^3 (top 6 inches of berm soil plus 38% of sub-liner soil to groundwater based on 1995 exploratory sampling)

Leach Pit – 0 ft^3 (based on multiple liners and limited, monitored usage)

Buried Transfer Lines – 2,700 ft^3 (5% of soil to depth of 4 feet and width of 4 feet below 3,400 linear feet of buried lines)

TOTAL – 128,000 ft^3 (est.)

3.7.3 Soil Washing

Soil washing is a process that uses water together with mixing and screening equipment to wash and segregate soil by particle size. Soil washing has been successfully employed for radioactive and chemical soil cleanup at a number of sites in the United States and has been specifically tested on the Hanford site on soils similar to those at Framatome. Uranium tends to preferentially adhere to the finer-size particles. Segregating the fine fraction from the larger-sized particles, combined with the washing and agitation, is expected to leave a large-size fraction that is decontaminated to below radiological cleanup criteria. Soil washing is also expected to decontaminate the soil with respect to chemical contamination. The primary chemical analytes of concern, fluoride and nitrate compounds, are water soluble and are expected to be removed as a result of the water wash and particle size segregation operation.

At Framatome, the soil washing process will actually utilize a combination of equipment purchased specifically for the soil/sand remediation and equipment already in-place and being utilized in processing of the lagoon inventory. The newly purchased “head-end” equipment is a water-aided materials sieving process, utilizing a water spray and progressively finer meshed screens to separate the soil/sand into progressively smaller size fractions. The larger size fractions, based on their low surface to mass ratio, are not significantly associated with the uranium contamination (as compared to the “fines” fraction) and are also much easier washed free of both uranium and non-radiological chemical contamination by the water action. It is anticipated that the coarse (“screened out”) fractions will meet the performance criteria without further processing, with the performance criteria being the cleanup limits set forth in Section 3.1.5.2. As a contingent measure, the coarse fractions could be re-routed through the washing-screening equipment a second time or alternatively, be packaged for offsite disposal.

The fines fraction, along with the major portion of the uranium and chemical contamination, will be contained in the liquid stream passing the screens. This aqueous stream will be transferred to the existing Solids Processing Facility (SPF) where the fines will be separated out and dewatered via the SPF filter press. The dewatered fines are destined for disposal at the Envirocare site in Utah. As a contingent measure, volumes of fines requiring offsite disposal may be reduced by utilizing hot water and chemical leaching steps available in the SPF upstream of the filter press. As in the case of the coarse fractions, the performance criteria for permanent return of fines to the lagoon area will be compliance with the cleanup levels of Section 3.1.5.2. The liquid phase separated from the fines at the filter press will be processed in FANP’s existing wastewater treatment process, which includes removal of uranium to trace levels. All liquid effluent discharges will meet the requirements of FANP’s State Waste Discharge Permit, ST-3919.

Waste streams associated with the soil washing process are summarized in Table 3, Summary of Closure Related Waste Streams.

3.7.4 Verification Survey and Sampling

Framatome will utilize discrete samples analyzed for the applicable COCs (Section 3.1.5.1) to verify that the sand and soil destined for retention onsite meet applicable MTCA Method B cleanup limits (Section 3.1.5.2). The remediated impoundment area will be sampled based on an established sampling grid and the collection of random samples within that grid. Washed sand/soil from the soil washing process will be sampled on a periodic basis for comparison to soil cleanup levels. Only sand/soil meeting cleanup levels and covered by an Ecology contained-in determination will be eligible for return to the lagoon area as fill, and then only after the receiving lagoon area has been verified to meet cleanup levels. The verification survey sampling is described more fully in the sampling and analysis plan (Appendix B), including descriptions of the sampling grid, number of samples, locations of samples, sampling protocols, analytical methods, and data evaluation techniques.

3.8 *Sand and Soil Storage, Packing, and Disposal*

Environmental media (soil and sand) not decontaminated/verified to meet cleanup levels will be packaged and shipped off site to Envirocare of Utah for disposal. Soils will be sampled, analyzed, and packaged in accordance with the Envirocare waste disposal criteria.

3.8.1 Sand and Soil Storage

Contaminated interstitial sand, i.e., sand not meeting cleanup limits, will be removed from between liners and stored within the lagoon operating unit pending processing in the soil washing unit. Non-contaminated sand, i.e., sand meeting cleanup limits, will be stored separately from the contaminated sand and will be returned to the lagoon area upon completion of closure activities. Contaminated soil removed from under the bottom lagoon liners will be managed in the same manner as the contaminated interstitial sand, by placing it in the contaminated waste pile pending processing in the soil washing unit. Additional waste piles of high or mid-range contaminated sand and soils may also be utilized while determining the efficiency of the soil washing process. If removal of clean soil, i.e., soil meeting cleanup limits, is necessary, it will be segregated from the contaminated sand and soil. Soil pending sampling or awaiting sample results will be stored separately from the clean and contaminated waste piles. All sand and soil storage areas, contaminated and non-contaminated, will be covered with tarps as deemed necessary to prevent wind dispersion. Alternative anti-dispersants such as soil fixatives may also be used if necessary.

3.8.2 Soil Packaging and Containerization

Contaminated sands and subsoils requiring disposal will be containerized in 96-cubic foot steel burial boxes, large “roll-off” containers, or other appropriate disposal containers. Containers will be lined with heavy-duty plastic to prevent leakage. Liner sands and subsoils will be placed in the containers by hand or appropriate heavy equipment, such as a front loader type tractor. When full, the exterior of each container will be cleaned and surveyed by a health and safety technician to ensure that all radiological contamination above releasable limits has been removed from the container.

3.8.3 Off-Site Transport and Disposal

The containerized materials removed from the surface impoundments area will be loaded onto tractor trailers and transported to the Envirocare of Utah site for disposal. Transport of the wastes will be conducted in accordance with the applicable DOT regulations for hazardous materials transport under 49 CFR 172, Subpart F. Contaminated soil will be placed in mixed waste cells at the Envirocare facility near Clive, Utah. The soil will be disposed in accordance with NRC and Utah State license requirements. Envirocare will supply Framatome with a certification of disposal for each batch disposed.

3.9 *Waste Management Unit Restoration*

Upon receipt of analytical results indicating that subsoils beneath the unit do not exceed applicable cleanup levels, previously removed sands and soils meeting cleanup levels (originally or after washing) and covered by an Ecology contained-in determination will be re-introduced and the unit will be backfilled to grade with engineered fill and certified as clean closed. Conventional construction techniques will be used to backfill, grade, and close the waste management unit. Consideration will be given to promotion of proper surface runoff and drainage. As set forth in the portion of Appendix A addressing the protection of terrestrial ecological receptors, Framatome will consider placement of a suitable physical barrier over the surface of the unit if an exception to the requirement for a terrestrial ecological evaluation is sought.

3.10 *Groundwater Monitoring*

As described in Section 2.1.6, Framatome currently monitors groundwater in the downgradient vicinity of the surface impoundments as part of its facility groundwater monitoring program. The groundwater monitoring program will continue in the vicinity of the surface impoundments for a minimum of two years following certification of closure in accordance with the closure plan. At the conclusion of the two-year monitoring period, the groundwater monitoring data will be evaluated versus the groundwater cleanup levels of Section 3.1.5.2 to verify the effectiveness of the DWMU closure with respect to protection of groundwater. As discussed in Section 3.1.7, this comparison will utilize data analysis/evaluation procedures consistent with WAC 173-340-720(9).

3.11 *Site Security*

Framatome's perimeter fences and locked access gates restrict unauthorized entry to the operating portions of the facility. Twenty-four hour guards and attendants regulate access to the facility through the front entrance and west entrance. Framatome employees and contractors are issued badges, and personnel and vehicles must pass through visual inspection at the west security entrance. Any person entering the facility must present a badge for access. All personnel on-site are required to exhibit badges at all times for identification.

4. Closure Schedule and Costs

4.1 *Schedule for Closure*

As previously noted in Section 1.1, the closure of the surface impoundment system is being conducted under the terms and schedule imposed by a consent decree agreement entered into between Ecology and FANP in 1996. The schedule is dictated via a series of enforceable milestones, as follows:

Milestone	Due Date	Status
Begin operating Lagoon Uranium Recovery (LUR) process	1/2/98	Completed
Begin operating Solids Processing Facility	7/7/98	Completed
Dry Conversion Facility in Operation	8/7/98	Completed
Cease Plant Discharges to Lagoon 3	7/17/00	Completed
All Lagoon Replacement Tanks in Operation	9/7/04	Design, Procurement, and Installation On-Going
All Lagoons Empty	9/8/04	Inventory Processing On-going
Submit Closure Certification	8/8/06	Closure Planning On-going

Due to the magnitude of the decontamination, demolition, remediation, and disposal activities associated with closure of the surface impoundments, and as recognized by the consent decree, the clean closure of the surface impoundments will not be accomplished within the 180 day timeframe specified in 40 CFR 265.113(b). Closure certification will be submitted within 60 days of completion of closure, but in no case later than the consent decree milestone of August 8, 2006, unless that milestone has been modified per joint FANP/Ecology action as defined in the consent decree.

4.2 ***Closure Cost Estimate***

The estimated closure costs for the surface impoundment system are the sum of the estimated costs for processing the remaining inventory of lagoon liquids and sludges plus the estimated costs of the physical remediation/closure of the impoundment structures and any impacted environmental media.

Inventory processing costs are essentially the operational and maintenance (O/M) costs for the four key wastewater treatment and recycling facilities discussed in Section 3.4., namely the Solids Processing Facility (SPF), Lagoon Uranium Recovery (LUR) process, Silica Removal Process (SRP), and Ammonia Recovery Facility (ARF). Included are the disposal costs for filter cake wastes produced by the SPF and SRP. Operating costs for these facilities are well understood based on actual operating history.

The costs for processing/disposal of the remaining surface impoundment inventory are given in Table 4. The costs are based on the inventory as of October 31, 2003 and assume continued operation of the lagoon wastewater treatment/recycling facilities on an accelerated schedule aimed at completing the inventory removal by June of 2004, approximately three months prior to the applicable consent decree milestone of September 2004.

The costs for remediation/closure of the surface impoundment structures and appurtenances, including contaminated environmental media, are provided in Tables 5 and 7 for labor and non-labor costs, respectively. The costs cover all major aspects of the work, including but not limited to planning and preparation; decontamination/demolition; soil washing; initial and final contamination surveys; waste packaging, shipping, and disposal; equipment procurement; and laboratory costs. It should be noted that the costs in Tables 5 and 7 address activities to meet Ecology closure criteria as well as NRC decommissioning criteria and as such are higher than costs associated only with activities to achieve clean closure as defined by Ecology. Examples of costed activities in which NRC-driven costs make up the larger share include planning and preparation, soil washing, waste shipping/disposal, equipment procurement, and laboratory support.

Total costs for implementation of the activities addressed in this plan are the sum of the Tables 4, 5, and 7 costs, plus contingency, as follows:

Table 4 Lagoon Inventory Processing	$1,942,000
Table 5 Surface Impoundment Remediation/Closure Labor	$3,369,197
Table 7 Surface Impoundment Remediation/Closure Non-Labor Costs	$4,479,645

Subtotal	$9,790,842
Contingency (10%)	$979,084
TOTAL	**$10,769,926**

4.3 ***Financial Assurance Mechanism for Closure and Liability Coverage***

Financial assurance for closure costs and for third-party liability for sudden and non-sudden accidental occurrences, as required by 40 CFR 265.143 and 40 CFR 265.147, respectively, are provided to Ecology via irrevocable standby letters of credit. These letters of credit are on file with Ecology's Hazardous Waste and Toxics Reduction Program.

Table 1 Surface Impoundment System Chemical Constituents

Waste	Waste Codes	Chemical Constituents	Listed Constituents
Lagoon 1, Lagoon 2 liquid	WT02	ammonium fluoride ammonium nitrate ammonium hydroxide uranium bearing solutions	N/A
Lagoon 3 liquid	WT02, F002, F003	ammonium fluoride sodium nitrate ammonium nitrate ammonium sulfate ammonium bicarbonate uranium bearing solutions	acetone (State-only) Freon (ppb)
Lagoon 3 solids	WT02, F002, F003	ammonium sulfate ammonium fluoride sodium fluorosilicate sodium fluoride calcium fluoride uranium bearing solids	acetone (State-only) Freon (ppb)
Lagoon 4 liquid	WT02, F003	ammonium fluoride ammonium sulfate ammonium nitrate uranium bearing solutions	acetone (State-only)
Lagoon 4 solids	WT02, F003	ammonium fluoride sodium fluoride sodium nitrate aluminum nitrate calcium fluoride uranium bearing solids	acetone (State-only)
Lagoon 5A liquid	WT02, F003	ammonium fluoride sodium fluoride ammonium sulfate ammonium nitrate ammonium bicarbonate uranium bearing solutions	acetone (State-only)
Lagoon 5A solids	WT02, F003	ammonium fluoride sodium fluoride aluminum sulfate calcium fluoride uranium bearing solids	acetone (State-only)

Waste	Waste Codes	Chemical Constituents	Listed Constituents
Lagoon 5B liquid	WT02, F003	ammonium fluoride ammonium nitrate ammonium sulfate ammonium bicarbonate sodium fluoride uranium bearing solutions	acetone (State-only)
Lagoon 5B solids	WT02, F003	ammonium fluoride sodium fluoride ammonium sulfate ammonium nitrate ammonium bicarbonate uranium bearing solids	acetone (State-only)

Table 2 Surface Impoundment Physical Characteristics

Surface Impoundment	Year of Construction	Approximate Dimensions (feet)	Maximum Capacity (Gallons)	Working Capacity (Gallons)*	Berm Side Slope Angles	Liners
Lagoon 1	1971	245 x 219 x 3.5	1,300,000	1,300,000 (covered)	Exterior: 3H:1V Interior: 2H:1V	2 HDPE (80-mil) liners with intervening GEONET leak detection system plus HDPE cover (1992). (Earlier liners breached. See Note below.)
Lagoon 2	1971	245 x 119 x 3.5	700,000	700,000 (covered)	2H:1V	Petromat liner (1971). 2 Hypalon liners (45-mil primary, 36-mil secondary) with intervening sand and leak detection system (1978). 1 HDPE liner (60-mil) plus 60-mil HDPE cover (1989).
Lagoon 3	1974	382.5 x 243 x 7.1	4,300,000	2,900,000 (2 ft. freeboard)	3H:1V	Petromat liner (1974). 2 Hypalon liners (45-mil primary, 36-mil secondary) with intervening sand and leak detection system (1979).
Lagoon 4	1979	287.5 x 240.5 x 6	3,100,000	2,100,000 (2 ft. freeboard)	Exterior: 2H:1V Interior: 3H:1V	2 Hypalon liners (45-mil primary, 36-mil secondary) with intervening sand and leak detection system (1983). 1 HDPE liner (80-mil) (1989).
Lagoon 5A	1982	240 x 175 x 7.54	1,900,000	1,300,000 (2 ft. freeboard)	3H:1V	1 Hypalon liner (36-mil) (1982). 1 Hypalon liner (45-mil) with intervening sand and leak detection system (1983).
Lagoon 5B	1983	240 x 175 x 7.54	1,900,000	1,300,000 (2 ft. freeboard)	Exterior: 2H:1V Interior: 3H:1V	2 Hypalon liners (45-mil primary, 36- mil secondary) with intervening sand and leak detection system (1983).

Note: A Petromat liner (installed in 1971), two Hypalon liners (45-mil primary, 36-mil secondary) with intervening sand and leak detection system (installed in 1979), as well as a Hypalon cover (installed in 1983) are in place beneath the HDPE liners but are known to have been breached.

* Two feet of freeboard are required per 40 CFR 265.222 to prevent overflowing of lagoon inventories. Lagoons 1 and 2 have covers, and are therefore exempt from this requirement.

Table 3 Summary of Closure-Related Waste Streams

Waste Stream	Waste Designation	Intermediate Disposition	Final Disposal
Contaminated lagoon liners not amenable to decontamination (Petromat, Hypalon, some HDPE)	F002, F003, WT02	Package into disposal containers	Envirocare as a mixed waste
HDPE liner material	F002, F003, WT02 (prior to decontamination)	Treat per 40 CFR 268.45 Table 1 for dangerous waste and radiological release	Roosevelt Subtitle D Landfill as industrial waste
HDPE decontamination solution	F002, F003	Evaporation or filtration and liquid uranium recovery	FANP wastewater treatment system, POTW
Soil/sand with contamination exceeding cleanup capability	F002, F003, WT02	Package into disposal containers	Envirocare as a mixed waste
Soil/sand with contamination >Radiological cleanup level	F002, F003, WT02 (prior to decontamination)	Soil washing, staged for replacement into excavation after verification of compliance with cleanup levels	Contained-in determination, place back into excavation
Soil/sand < cleanup level	F002, F003 (prior to decontamination)	Staged for replacement into excavation after verification of compliance with cleanup levels	Contained-in determination, place back into excavation
Soil/sand wash fines	F002, F003 (prior to decontamination)	Package into disposal containers or recycle	Envirocare as a mixed waste
Soil/sand wash liquid	F002, F003	Filtration and liquid uranium recovery	FANP Wastewater treatment system, POTW in compliance with state waste discharge permit limits

Waste Stream	Waste Designation	Intermediate Disposition	Final Disposal
Lagoon piping	F002, F003, WT02	Package into disposal containers	Envirocare as a mixed waste
Non-contaminated debris (concrete, metal, wood, etc.)	N/A	Collect in roll-off boxes	Roosevelt Subtitle D Landfill as industrial waste
Contaminated debris (concrete, metal, plastic, etc.) amenable to decontamination	F002, F003, WT02 (prior to decontamination)	Treat per 40 CFR 268.45 Table 1 for dangerous waste and radiological releases	Roosevelt Subtitle D Landfill as industrial waste
Sand blast media from concrete decontamination	F002, F003	Package into disposal containers	Envirocare as a mixed waste
Radiologically contaminated debris not amenable to decontamination (wood, some plastic, etc.)	F002, F003, WT02	Package into disposal containers	Envirocare as a mixed waste
Protective clothing	N/A	Packaged as LLRW	Onsite washing, onsite incineration
Excavation Equipment – Bobcat, tractor, etc.	N/A	Remove radiological decontamination if possible	Release as non-contaminated or manage as low level radioactive waste
Equipment decontamination solutions	N/A, low level radioactive waste	Filtration and liquid uranium recovery	FANP wastewater treatment system, POTW

Table 4 Lagoon Inventory Processing Costs (October 31, 2003 Basis)

Facility	Labor, $	Materials, $	Total Costs, $
ARF	54,000[(1)]	463,000 (caustic) 131,000 (natural gas) 33,000 (electricity) 2,000 (sulfuric acid)	683,000
SRP	54,000[(1)]	20,000 (Perlite) 43,000 (caustic) 33,000 (electricity) 2,000 (sulfuric acid) 624,000 (filter cake disposal)[(2)]	776,000
LUR	21,000[(3)]	28,000 (reductant)	49,000
SPF	80,000[(4)]	12,000 (cellulose) 342,000 (filter cake disposal)[(5)]	434,000
TOTAL			1,942,000

(1) Based on annual labor costs of $86/yr.

(2) Packaging, transportation and disposal costs for approximately 7,800 ft^3 of filter cake.

(3) Based on labor costs of $40K/yr.

(4) Based on labor costs of $126K/yr.

(5) Packaging, transportation and disposal costs for approximately 4,275 ft^3 of filter cake.

Table 5 Surface Impoundment Remediation/Closure Labor Costs*

Work Category	Work Activity	Labor Required, Days	Labor Cost, $
Planning and Preparation	Preparation and submittal of NRC facility license amendment, NRC Decommissioning Plan, and Ecology Closure Plan	Staff Eng., 196 Sr. Eng. II, 25 Eng. III, 44 NRC, 27 Consultant, 62	113,092 12,250 16,412 31,104 49,600
	Development of radiological and chemical work plans	Eng. III, 27	10,071
	Selection and procurement of radiological and chemical special equipment	Eng. III, 11 Eng. II, 11	4,103 3,564
	Special training for remediation workers	Eng. III, 2 Tech. IV, 4 Operator, 2 Common, 8	746 1,036 1,120 960
	Radiological/chemical pre-remediation characterization survey	Tech. IV, 260 Consultant, 62 Operator, 130 Common, 520	67,340 49,600 72,800 62,400
Decontamination/ Dismantling of Facility Components	Removal, decontamination, and/or disposal preparation of liners, piping, and miscellaneous equipment	Tech. IV, 314 Common, 1973	81,326 236,760
Restoration of Contaminated Areas	Aqueous and chemical washing of lagoon inter-liner sands and sub-lagoon contaminated soils	Tech. IV, 2836 Common, 2836 Eng. III, 473	734,524 340,320 176,429
	Soil removal/transport and sampling (restoration support)	Tech. IV, 1040 Common, 2080 Operator, 520	269,360 249,600 291,200
Final Unit Contamination Survey	Final chemical and radiological survey of remediated unit	Tech. IV, 260 Common, 520 Operator, 130	67,340 62,400 72,800
Project Administration	Overall project management of both NRC decommissioning and Ecology closure activities	Eng. III, 780	290,940
TOTAL Labor Costs			3,369,197

* Based on daily (8-hr) labor rates provided in Table 6, Worker Unit Cost Schedule – Surface Impoundments.

Table 6 Worker Unit Cost Schedule - Surface Impoundments

Estimate of labor costs.

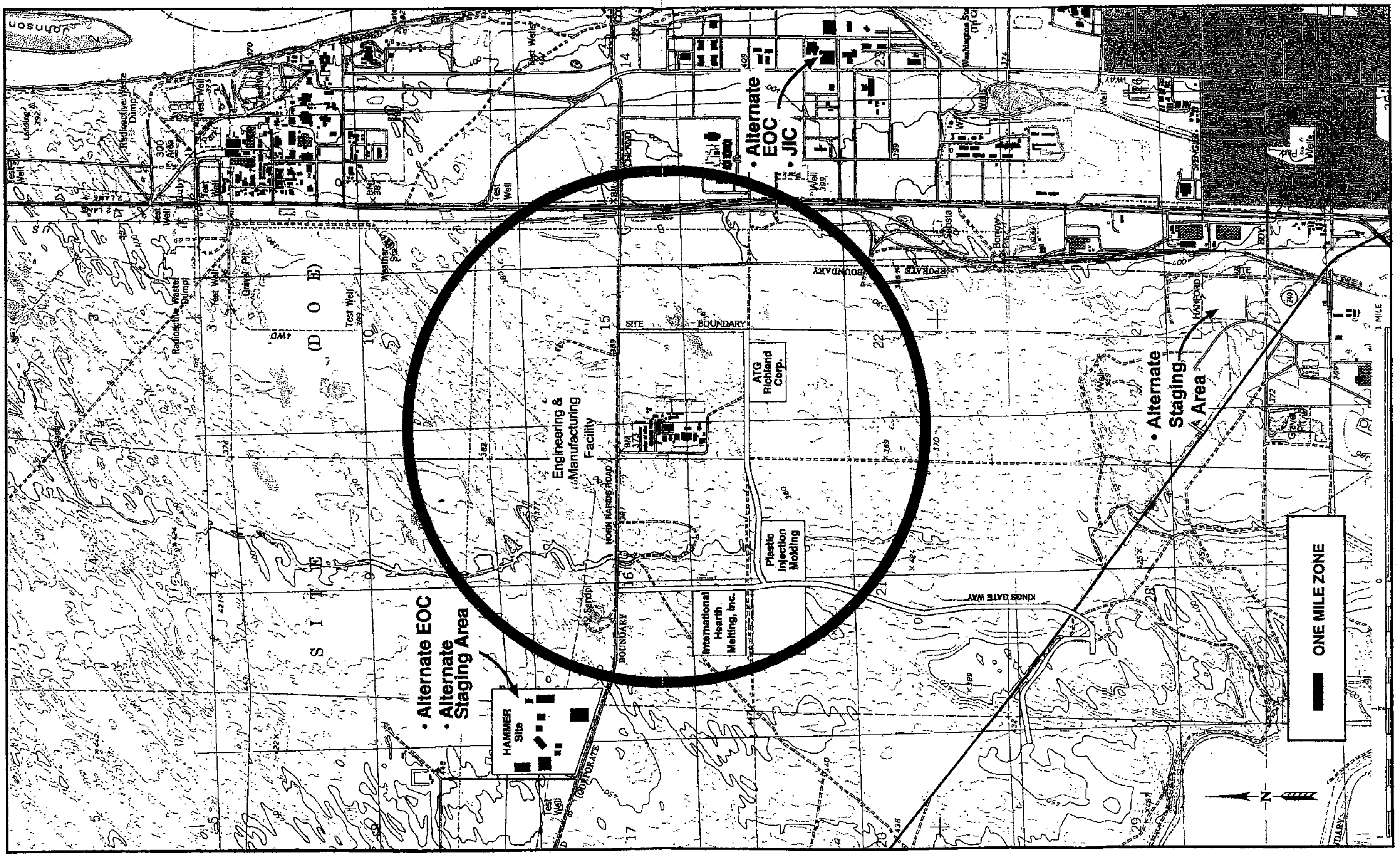
Labor Cost Component	Labor Category Eng. Assoc.	Labor Category St. Eng.	Labor Category Sr. Eng. II	Labor Category Eng. III	Labor Category Eng. II	Labor Category Tech. IV	Labor Category Driver & Front Loader	Labor Category Common	Labor Category NRC	Labor Category Consultant
Total Cost Per Year, $	188,690	150,068	127,298	96,998	84,193	67,264	145,600	31,200	299,520	208,000
Total Cost Per Work Day, $*	726	577	490	373	324	259	560	120	1,152	800

*Based on 260 work days per year.
Rounded to the nearest dollar.

Table 7 Surface Impoundment Remediation/Closure Non-Labor Costs

Cost Category	Cost Component Description	Unit Cost, $	Total Cost, $
Packing Material Costs	Rental of intermodel transport containers for soil and liners (8 for 2 years; 4 for 1 year)	4,380/container/yr.	87,600
	Purchase of 33 90-ft^3 burial boxes for piping/structures	820 ea.	27,060
Shipping/Disposal	Liners (18,822 ft^3)	57.11/ft^3	1,074,924
	Soil (24,573 ft^3)	61.88/ft^3	1,520,593
	Ancillary Equipment (2,930)	112/ft^3	328,160
Equipment/Supplies	Misc. radiation instrument sources		20,000
	NaI radiation detectors (2)	2500 ea.	5,000
	Inductively Coupled Plasma/Mass Spectroscopy Laboratory Analyzer	100,000 ea.	100,000
	In-situ Gamma Analyzer	120,000	120,000
	Soil wash chemicals		215,385
	Fill dirt (34,750 cu. yd.)	5.65 cu. yd.	196,338
	Soil wash equipment		260,000
Laboratory Costs	Radiological characterization samples (3,591)	35 ea.	125,685
	Chemical characterization samples (378)	50 ea.	18,900
Miscellaneous Costs	State of WA inspections (3 yr.)	25,000/yr.	75,000
	NRC inspections (3 yr.)	30,000/yr.	90,000
	Site preparation		140,000
	Certification Survey		75,000
TOTAL Non-Labor Costs			4,479,645

Figure 1 Facility Location



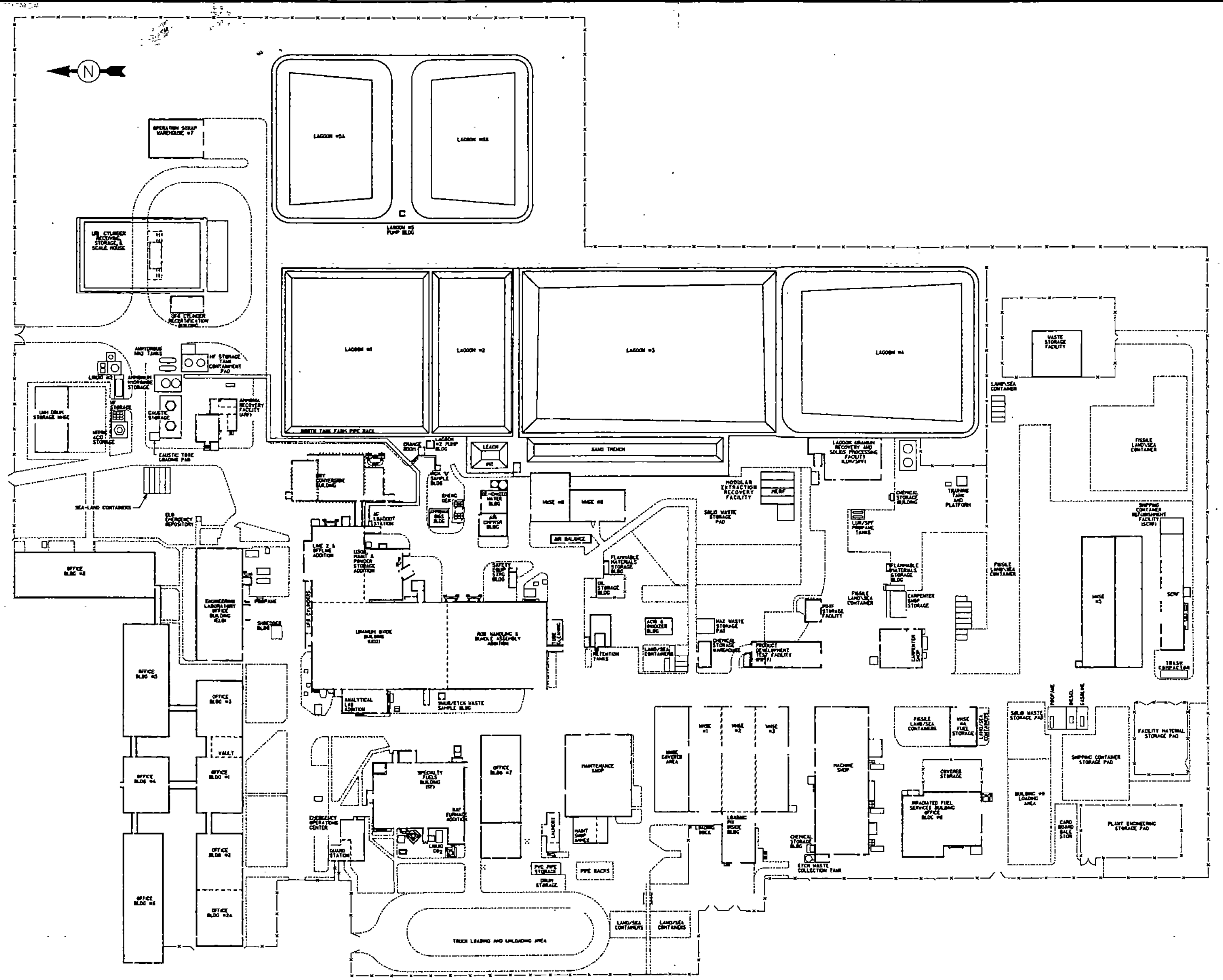


Figure 2 Site Plan

DCH 3/02	RAB 3/02	REMOVED PROPANE PAD IN FRONT OF GENERATORS PER ECN 7470.	31
DCH 3/02	RAB 3/02	AS-BUILT WRHS 5 SHIPPING CONTAINER STORAGE PER ECN-7273	30
DCH 5/01	TCH 5/01	REMOVED AND RELOCATED PROPANE TANKS PER ECN 7228	29
KHT 2/01	RAB 2/01	AS-BUILT LUR & ARF ADDITION PER AB007280	28
DCH 12/00	TCH 7/00	REMOVED PROPANE TANKS PER ECN 7069	27
ML 8/00	SS 8/00	AS BUILT, REV LAUND. PROPANE TK PER ECN 6883	26
APPROVED	DRAWN	REVISION DESCRIPTION	REV

FRAMATOME ANP, INC.

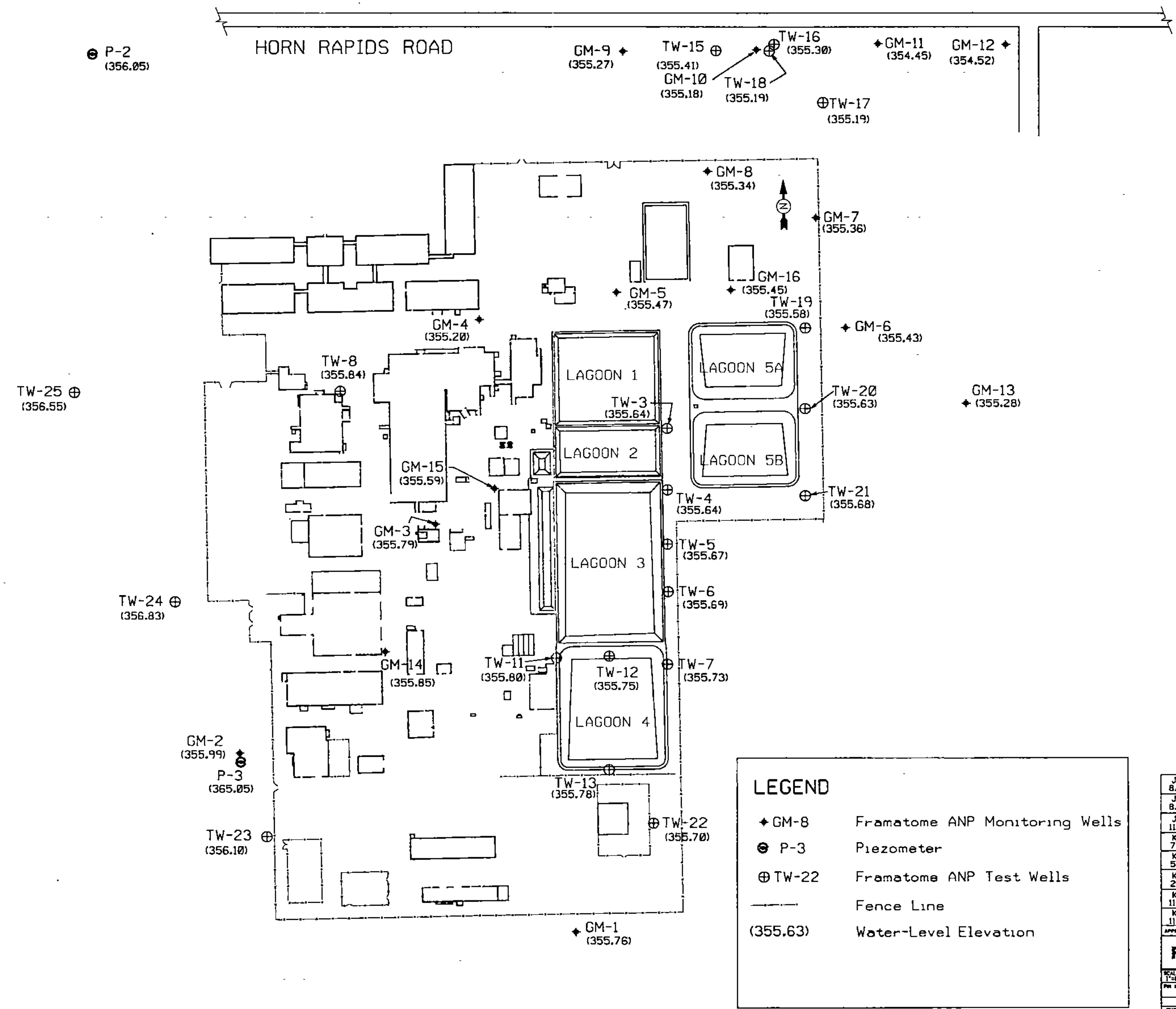
SCALE: 1" = 60'
PM NO. 110001

	DATE	NAME
DRAWN BY	10/30/85	WDB
CHECKED BY	1/14/86	MKV
APPROVED	1/14/86	ENV
APPROVED		
APPROVED		

NEXT USED ON

TITLE: FRAMATOME ANP SITE GENERAL ARRANGEMENT
SITE PLAN

DRAWING NO. EMF-607,590 REV 31 SH. NO. 2



SCALE ON 11X17 DRAWING: 1"=275'

Figure 3 Well Locations

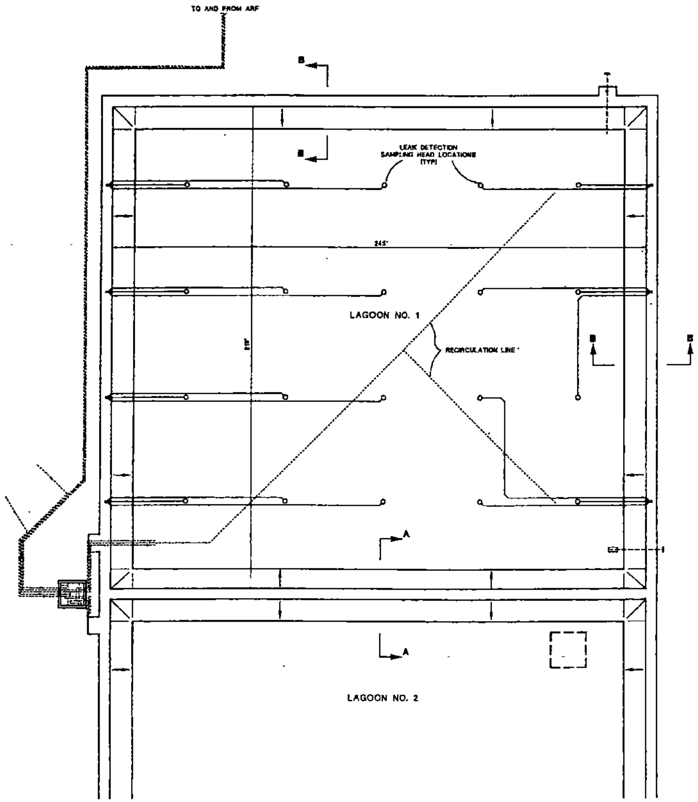
JBP 8/02	RAB 8/02	UP-DATED DRAWING FOR SECOND QUARTER 02	26
JBP 8/02	RAB 8/02	UP-DATED DRAWING FOR FIRST QUARTER 02	25
JBP 11/01	RAB 11/01	UP-DATED DRAWING FOR FOURTH QUARTER 01	24
KHT 7/01	RAB 7/01	UP-DATED DRAWING FOR THIRD QUARTER 01	23
KHT 5/01	RAB 5/01	UP-DATED DRAWING FOR SECOND QUARTER 01	22
KHT 2/01	RAB 2/01	UP-DATED DRAWING FOR FIRST QUARTER 01	21
KHT 11/00	RAB 11/00	UP-DATED DRAWING FOR FOURTH QUARTER 00	20
KHT 11/00	RAB 11/00	UP-DATED DRAWING FOR THIRD QUARTER 00	19
APPROVED	DRAWN	REVISION DESCRIPTION	REV

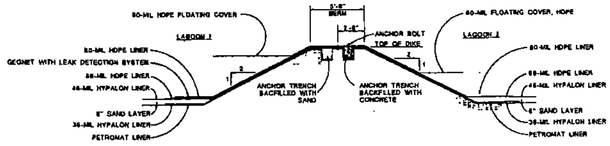
FRAMATOME ANP, INC.

SITE ENVIRONMENTAL MAPS TEST WELLS LOCATION

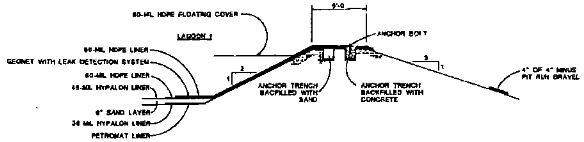
1"=60' ON FULL SIZE
110001
8/96 RAB
8/96 KHT
8/96 KHT

EMF-609,485 18 13





SECTION A-A
SCALE: 1/4"=1'-0"



SECTION B-B
SCALE: 1/4"=1'-0"

SCALE IN FEET

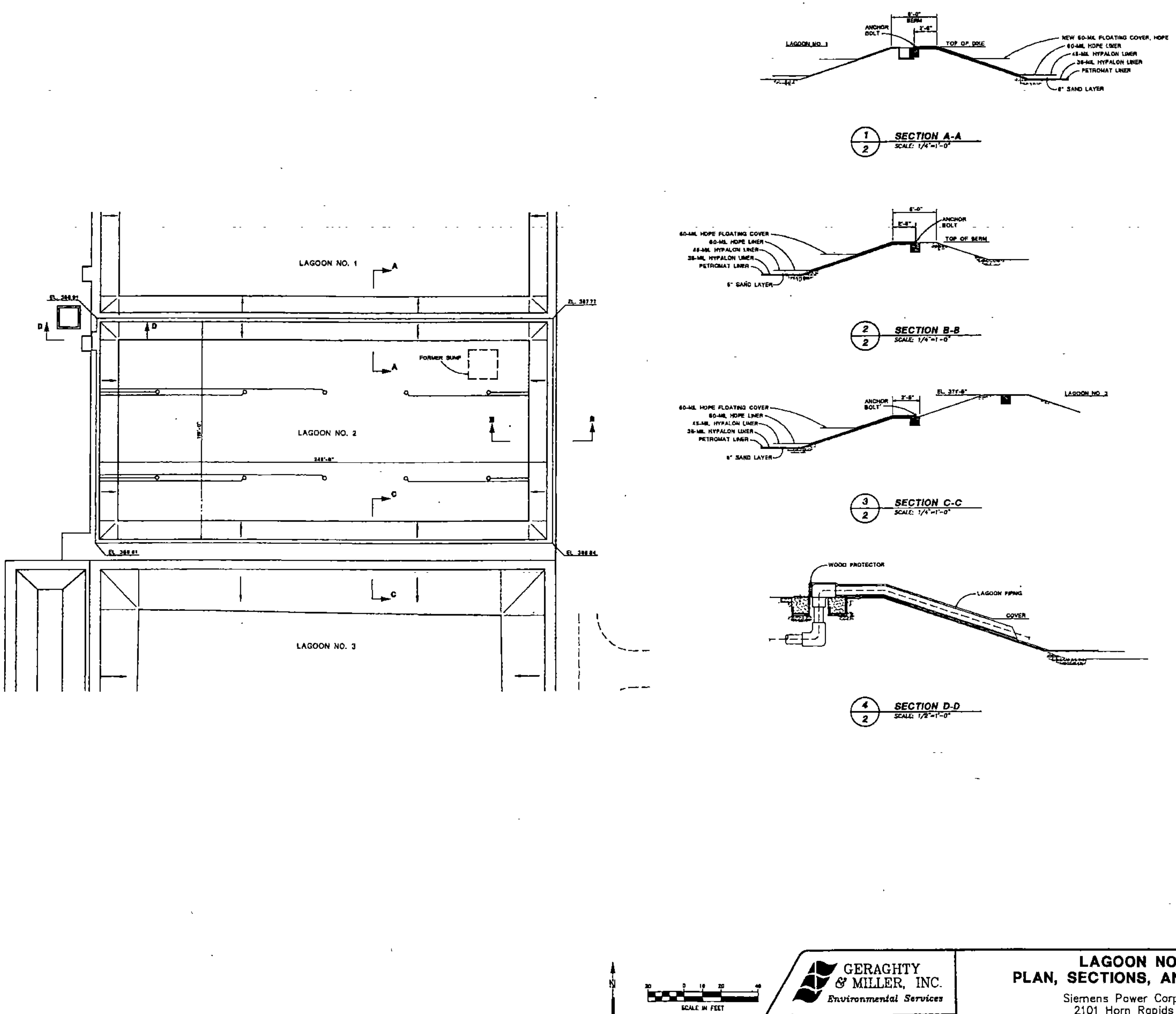
GERAGHTY & MILLER, INC.
Environmental Services

WA0183.008

LAGOON NO. 1
PLAN, SECTIONS, AND DETAILS

Siemens Power Corporation
2101 Horn Rapids Road
Richland, Washington

PLATE
1



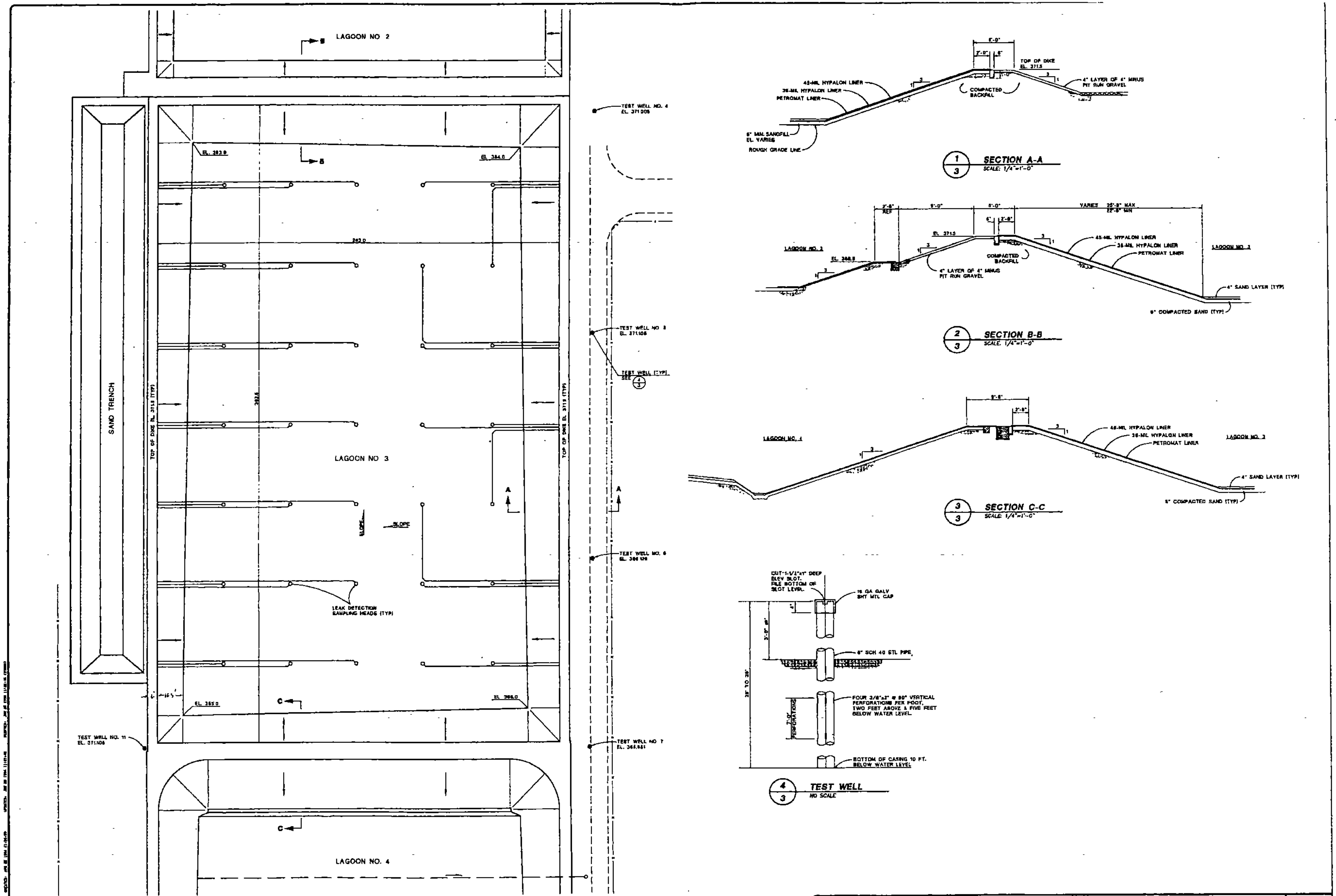
GERAGHTY & MILLER, INC.
Environmental Services

WA0183.008

LAGOON NO. 2
PLAN, SECTIONS, AND DETAILS

Siemens Power Corporation
2101 Horn Rapids Road
Richland, Washington

PLATE
2



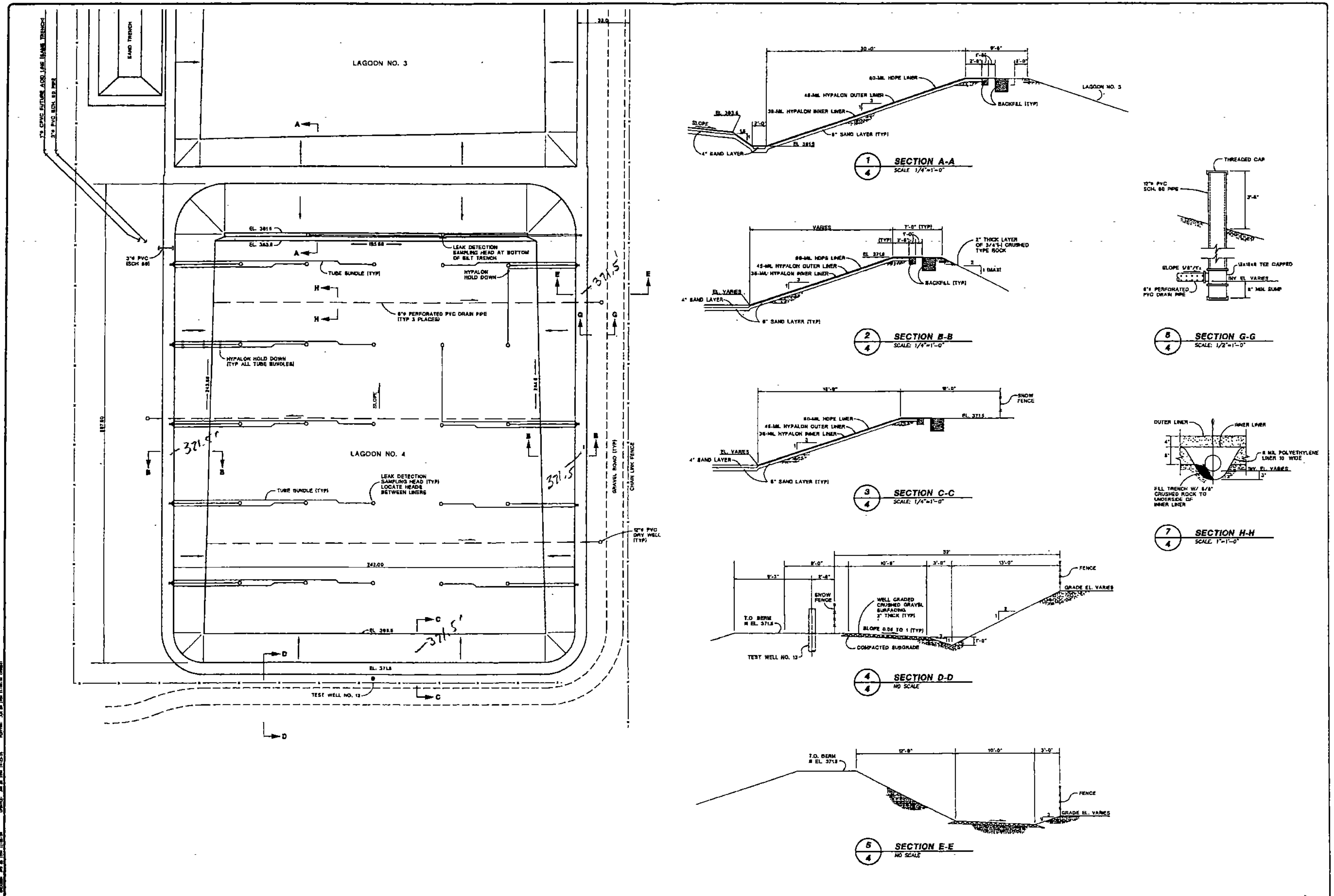
GERAGHTY & MILLER, INC.
Environmental Services

WA0183.008

LAGOON NO. 3
PLAN, SECTIONS, AND DETAILS

Siemens Power Corporation
2101 Horn Rapids Road
Richland, Washington

PLATE
3



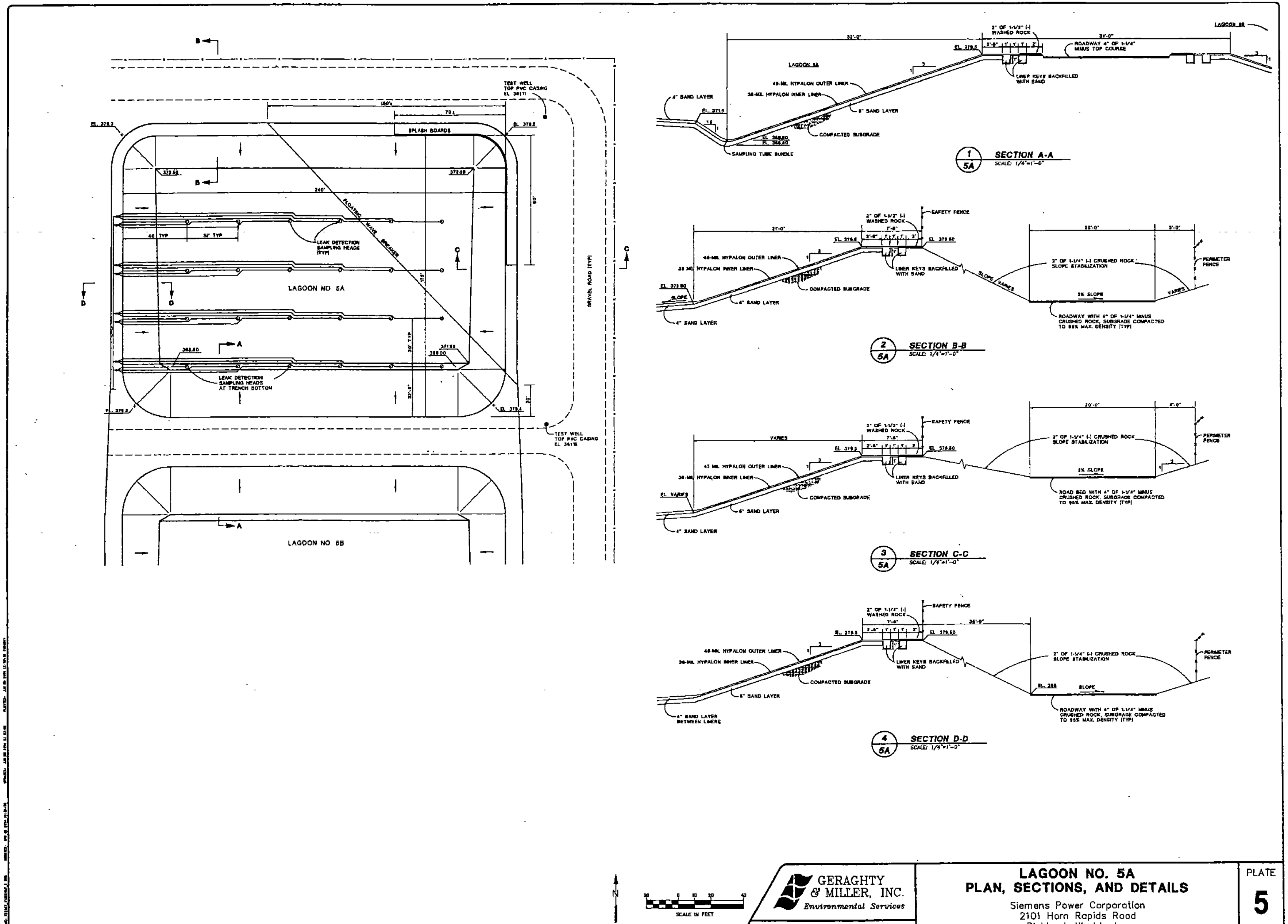
GERAGHTY & MILLER, INC.
Environmental Services

WA0183.008

LAGOON NO. 4
PLAN, SECTIONS, AND DETAILS

Siemens Power Corporation
2101 Horn Rapids Road
Richland, Washington

PLATE
4



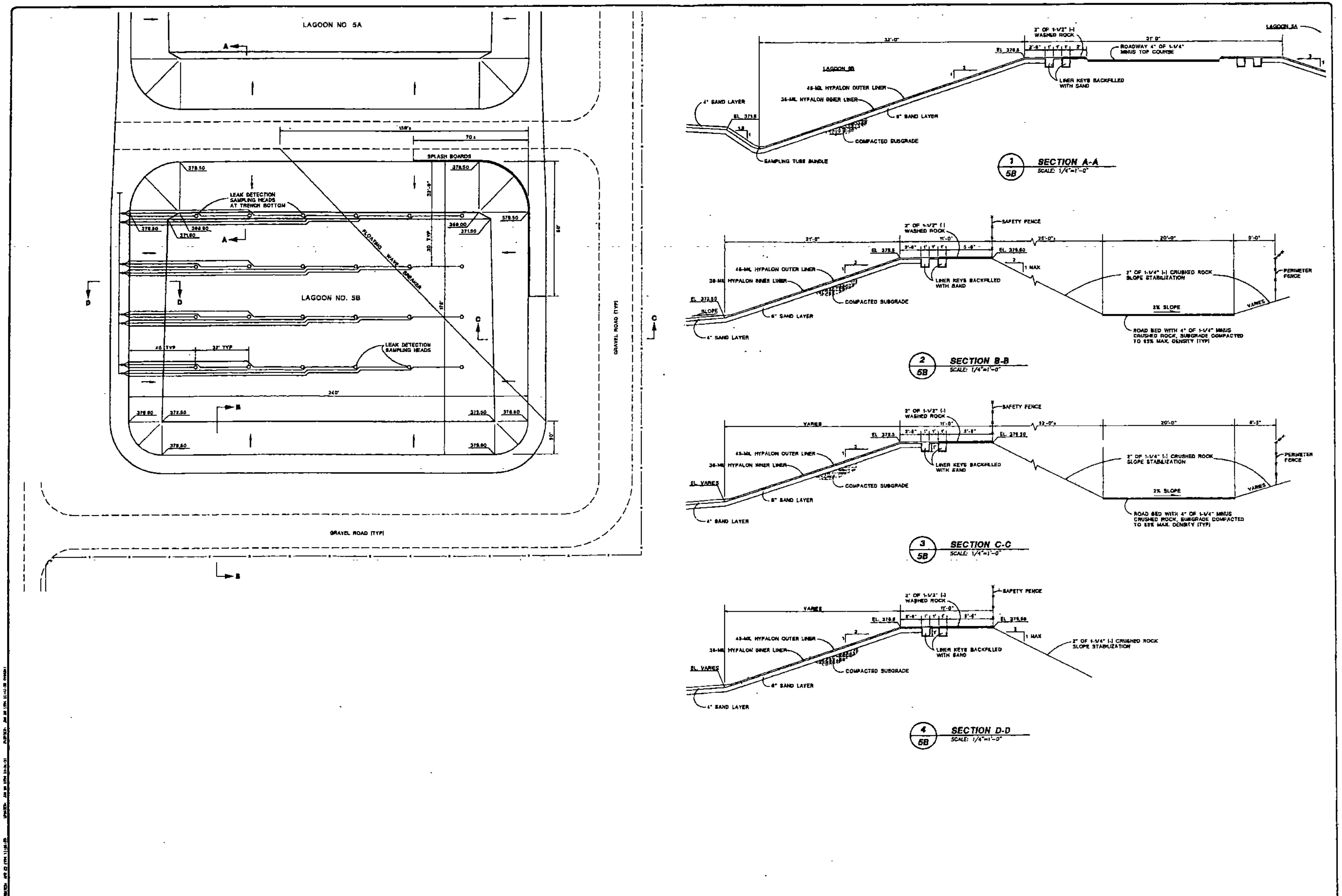
GERAGHTY & MILLER, INC.
Environmental Services

WA0183.008

LAGOON NO. 5A
PLAN, SECTIONS, AND DETAILS

Siemens Power Corporation
2101 Horn Rapids Road
Richland, Washington

PLATE
5



GERAGHTY & MILLER, INC.
Environmental Services

WA0183.008

LAGOON NO. 5B
PLAN, SECTIONS, AND DETAILS

Siemens Power Corporation
2101 Horn Rapids Road
Richland, Washington

PLATE
6

Appendix A – Development of MTCA Cleanup Levels

Introduction

The purpose of this appendix is to describe the development of groundwater and soil cleanup levels for use during closure of the surface impoundment system at the Framatome ANP, Inc. nuclear fuels fabrication facility in Richland, Washington. Groundwater and soil cleanup levels were developed using standard Method B procedures in accordance with the Washington State Model Toxics Control Act (MTCA) requirements specified at Washington Administrative Code (WAC) Chapter 173-340 Part VII. Cleanup levels were developed for the six identified constituents of concern (COCs) for the site: acetone; 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113); trichloroethene; fluoride; nitrate; and uranium.

Groundwater Cleanup Levels

Under WAC 173-340-720, standard Method B groundwater cleanup levels must be at least as stringent as:

- Concentrations established under applicable state and federal laws
- Concentrations protective of surface water beneficial uses (if applicable)
- Concentrations protective of human health.

Table A-1 summarizes the development of the groundwater cleanup levels. The potentially applicable criteria (derived considering the requirements bulleted above) are identified in the table. The resulting method B cleanup level, identified in the rightmost column of the table, is the most stringent of the potentially applicable criteria, unless an applicable state or federal MCL is found to be sufficiently protective (WAC 173-340-705).

Applicable State and Federal Laws

In accordance with MTCA, the highest beneficial use for groundwater is considered to be as a source of drinking water. Groundwater concentrations protective of drinking water were determined based on consideration of federal primary maximum contaminant levels (MCLs), state primary and secondary MCLs, and Ecology formula values, in accordance with WAC 173-340-720. Of the six COCs, state and/or federal MCLs have been established for fluoride, nitrate, uranium, and trichloroethene. MCLs are not available for acetone or Freon 113. The available MCLs are identified in Table A-1, which summarizes the development of Method B cleanup levels for the six COCs.

Protection of Surface Water

Surface water is not present adjacent to or in close proximity to the site.

Protection of Human Health

Concentrations protective of human health were obtained from CLARC version 3.1 (Ecology 2001). These concentrations, shown in Table A-1, are protective at a risk level of 1 in 1,000,000 for carcinogens or at a hazard quotient of 1.0 for non-carcinogens.

Soil Cleanup Levels

Under WAC 173-340-740, standard Method B soil cleanup levels must be at least as stringent as:

- Concentrations established under applicable state and federal laws
- Concentrations protective of terrestrial ecological receptors
- Concentrations protective of groundwater
- Concentrations protective of direct human contact with soil.

The soil to vapor pathway must also be evaluated whenever a cleanup level for a volatile organic compound (VOC) is significantly higher than the concentration for protection of drinking water that is calculated using the Washington State Department of Ecology (Ecology) partitioning model [defined in WAC 173-340-747]. If Framatome opts to make an empirical demonstration that a higher cleanup level is protective of groundwater [under WAC 173-340-747(3)(f)], the soil to vapor pathway must be considered for VOCs [WAC 173-340-740(3)(b)(iii)]. While it is expected that the remediation will be effective in removal of VOCs from soil to levels which are below cleanup levels calculated using the partitioning model, it is recognized that the soil to vapor pathway will need to be evaluated for VOCs if these levels are not achieved.

Table A-2 summarizes the development of the soil cleanup levels. The resulting method B cleanup level for each constituent, identified in the rightmost column of the table, is the most stringent of the potentially applicable criteria.

Applicable State and Federal Laws

For soil, there are no cleanup levels established under applicable state (other than MTCA) or federal laws.

Protection of Terrestrial Ecological Receptors

For unrestricted land uses, soil cleanup levels must be protective of terrestrial plants, wildlife, and ecologically important functions of soil biota that affect plants or wildlife. At the conclusion of the remedy implementation, Framatome will evaluate residual concentrations of constituents and the geometry of the contaminated area to determine whether the site qualifies for a simplified terrestrial ecological evaluation under WAC 173-340-7491(2). If the site does not qualify for the simplified evaluation, Framatome intends to pursue an exemption to the requirement for a terrestrial ecological evaluation under WAC 173-340-7491(1)(b) through placement of a physical barrier that will prevent plants or wildlife from being exposed to any residual soil contamination.

Protection of Groundwater

In accordance with MTCA, the highest beneficial use for groundwater is considered to be as a source of drinking water. Groundwater concentrations protective of drinking water were determined in accordance with WAC 173-340-720, as described above. Soil concentrations protective of groundwater were calculated using Ecology's variable parameter three-phase partitioning model [WAC 173-340-747(5)], which uses the following equation:

$$C_s = C_w(UCF)DF\left[K_d + \frac{(\Theta_w + \Theta_a H_{cc})}{\rho_b}\right] \qquad \text{(MTCA Equation 747-1)}$$

Where:

C_s	=	soil concentration (mg/kg)
C_w	=	groundwater cleanup level (µg/l); see Table 1
UCF	=	unit conversion factor (1 mg / 1,000 µg)
DF	=	dilution factor; see below
K_d	=	distribution coefficient (l/kg); see below
Θ_w	=	water-filled porosity
Θ_a	=	air-filled porosity
H_{cc}	=	Henry's law constant
ρ_b	=	dry soil bulk density

Chemical-specific input parameters (i.e., distribution coefficient, Henry's law constant) that were not available in MTCA or *Cleanup Levels and Risk Calculations under the Model Toxics Control Act Cleanup Regulation* (CLARC version 3.1; Ecology, November 2001) were obtained from other sources as indicated in Table A-3. The distribution coefficient, K_d, was calculated using the following equation for organic compounds:

$$K_d = K_{oc} \times f_{oc} \qquad \text{(MTCA Equation 747-2)}$$

where:

K_{oc} = soil organic carbon – water partitioning coefficient (ml/g)

f_{oc} = soil fraction of organic carbon (assumed 0.1 percent)

The dilution factor was calculated using site-specific data according to the following equations [see WAC 173-340-747(5)(f)].

$$DF = \frac{(Q_p + Q_a)}{Q_p} \qquad \text{(MTCA Equation 747-3)}$$

$$Q_a = K \times A \times I \qquad \text{(MTCA Equation 747-4)}$$

$$Q_p = L \times W \times Inf \qquad \text{(MTCA Equation 747-5)}$$

where:

DF	=	dilution factor
Q_p	=	volume of water infiltrating (m^3/yr)
Q_a	=	groundwater flow volume (m^3/yr)
K	=	hydraulic conductivity (m/yr)
A	=	aquifer mixing zone (m^2)
I	=	gradient (m/m)
L	=	estimated length of contaminant source area parallel to groundwater flow (m)
W	=	Unit width (1 m)
Inf	=	infiltration (m/yr)

The volume of water infiltrating, Q_p, was calculated using the average rainfall since 1946 based on Hanford records (Hanford Meteorological Station, Pacific Northwest National Laboratory) of 6.79 inches per year (0.172 m/yr) and the default assumption [per WAC 173-340-747(5)(f)(ii)] that east of the Cascade Mountains 25 percent of the rainfall infiltrates (for an infiltration rate of 0.0431 m/yr). The length of the contaminant source area parallel to the groundwater flow direction was conservatively assumed to be equivalent to the length of the maximum groundwater flow path beneath the impoundment system footprint (approximately 420 m). This results in a value for Q_p of 18 m^3/yr.

The groundwater flow volume, Q_a, was calculated using the hydraulic conductivity value determined during previous investigations (Geraghty & Miller, Inc. 1992) of approximately 1650 to 1800 ft/day [average value of 1725 ft/day, or (192,000 m/yr) used in the calculation], a gradient of 0.001 m/m based on recently collected water level data (Framatome 2003), and an aquifer cross-sectional area of 6 m^2, based on site-specific hydrogeologic information (unit width of 1 m and upper aquifer thickness of approximately 6 m, as documented in boring logs presented in Geraghty & Miller 1994). (Stratification of constituent concentrations within the upper aquifer was not observed during the RI; the aquifer was observed to be well-mixed.) Using these parameter values, the groundwater flow volume, Q_a, is estimated to be 1,150 m^3/yr.

The dilution factor, based on the calculated values for Qp and Qa, is approximately 65 (unitless). This value was used in MTCA Equation 747-1, to derive soil cleanup values protective of groundwater (see Table A-3).

Protectiveness of soil concentrations with respect to groundwater may also be evaluated using an empirical demonstration in accordance with WAC 173-340-747(3)(f). Framatome may desire to make such a demonstration for some of the constituents at the conclusion of the remedial action.

Protection of Direct Human Contact

Concentrations protective of direct human contact were obtained from CLARC version 3.1 (Ecology 2001). These concentrations, shown in Table A-2, are protective at a risk level of 1 in 1,000,000 for carcinogens or at a hazard quotient of 1.0 for non-carcinogens.

Adjustment of Cleanup Levels

Human health protectiveness considering exposure to multiple constituents must also be evaluated. This adjustment is typically done prior to or during cleanup, when it is known what constituents are actually present and their relative concentrations. Total carcinogenic risk from all constituents present must not exceed 1 in 100,000; the hazard index must not exceed 1.0. Only one of the COCs, trichloroethene, is considered to be a carcinogen; therefore, no adjustment of cleanup levels for total site carcinogenic risk is necessary. The other five COCs are non-carcinogens. Cleanup levels for exposure to multiple non-carcinogenic constituents with the same toxic effect are to be adjusted so that the hazard index is not greater than 1.0. Non-carcinogenic toxic effects for COCs are listed in Table A-1. Acetone and uranium both exhibit the same toxic effect, nephrotoxicity, so the allowable hazard index of 1.0 should be apportioned between them, if both are present. This adjustment should be made for groundwater cleanup levels and soil cleanup levels protective of direct human contact. No adjustments to acetone or uranium cleanup levels based on exposure to multiple constituents have been made in the current calculations. The need for the adjustment will be evaluated based on acetone/uranium concentration data gathered during the actual cleanup work.

There are no other toxic effects that are exhibited by more than one of the COCs; therefore, no other cleanup levels would need adjustment for exposure to multiple constituents.

Table A-1 Determination of Method B Groundwater Cleanup Levels
Framatome ANP, Richland, WA

Chemical Name	Non-carcinogenic Toxic Effect	Federal Standards	WA State Board of Health MCLs		Method B Groundwater Standard Formula Values		Preliminary Method B Groundwater Cleanup Level µg/L
		MCL µg/L	Primary µg/L	Secondary µg/L	Carcinogen µg/L	Non-carcinogen µg/L	
Acetone	Nephrotoxicity, Hepatotoxicity					800	800
Freon 113	No Non-carcinogenic Effects Listed					480,000	480,000
Trichloroethene	No Non-carcinogenic Effects Listed	5			3.98		5
Soluble Fluoride	Dental Fluorosis	4,000	4,000	2,000		960	960
Nitrate (as N)	Methemoglobinemia	10,000	10,000			1,600	1,600
Uranium, Soluble Salts	Weight, Nephrotoxicity	30				48	30

Notes:
Freon 113 = 1,1,2-Trichloro-1,2,2-trifluoroethane
µg/L = microgram per liter
MCL = maximum contaminant level

Federal MCL for uranium effective 12/8/03

Table A-2 Determination of Method B Soil Cleanup Levels
Framatome ANP, Richland, WA

Chemical Name	Method B Soil Cleanup Level Protective of Groundwater as Drinking Water (mg/kg)	Direct Contact Pathway (Ingestion Only) Method B: Unrestricted Land Use Standard Formula Values		Method B Soil Cleanup Level Protective of Direct Human Contact (mg/kg)	Preliminary Soil Cleanup Level Protective for All Pathways (mg/kg)
		Carcinogen (mg/kg)	Non-Carcinogen (mg/kg)		
Acetone	10.4		8,000	8,000	10.4
Freon 113	68,000		2,400,000	2,400,000	68,000
Trichloroethene	0.11	90.9		91	0.11
Soluble Fluoride			4,800	4,800	4,800
Nitrate (as N)			8,000	8,000	8,000
Uranium, Soluble Salts	17.7 (42 pCi/g)		240	240	17.7 (42 pCi/g)

Notes:
Freon 113 = 1,1,2-Trichloro-1,2,2-trifluoroethane
mg/kg = milligrams per kilogram

The mg/kg to pCi/g conversion for uranium assumes a uranium enrichment of 3.5% U-235.

Cleanup level protective of groundwater calculated per WAC 173-340-747(5); see Table A-3 for input parameters

Table A-3 Parameter Values for Three Phase Partitioning Model
Framatome ANP, Richland, WA

Chemical Name	Preliminary Method B Groundwater Cleanup Level [1] (µg/L)	Distribution Coefficient Kd (L/kg)	Henry's Law Constant (unitless)	Notes	Dilution Factor [2] (unitless)	Calculated Method B Soil Cleanup Level Protective of GW as DW [3] (mg/kg)
Acetone	800	0.0000575	0.00159	4	65	10.4
Freon 113	480,000	0.16	21	5	65	68,016
Trichloroethene	5	0.094	0.422	4	65	0.107
Soluble Fluoride	960	n/a	n/a	6		
Nitrate (as N)	1,600	n/a	n/a	6		
Uranium, Soluble Salts	30	8.9	0	7	65	17.7

Notes:
1. Preliminary Method B groundwater cleanup level - see Table A-1
2. Calculated per MTCA Equation 747-3; see appendix text
3. Calculated per MTCA Equation 747-1 using default parameters with exception of dilution factor; see appendix text
4. Source: CLARC 3.1
5. Source : EPA Region 9 PRG 2002
6. n/a = no data available in readily available sources
7. Hanford documents PNNL 14022 and BHI-01667

Freon 113 = 1,1,2-Trichloro-1,2,2-trifluoroethane

Appendix B - Sampling and Analysis Plan

Closure of Surface Impoundments

Framatome ANP, Inc.

Richland, Washington

1. Characterization Objectives

The objective of this Sampling and Analysis Plan (SAP) is to establish the procedures for characterization, sampling and analysis of soils and other contaminated media associated with closure of the surface impoundments (lagoons), their associated ancillary equipment, and two adjacent temporary holding areas – the sand trench and leach pit. Sampling and analyses will be conducted so as to meet the requirements of Washington State's Model Toxics Control Act (MTCA, Chapter 173-340 WAC), Dangerous Waste Regulations (Chapter 173-303 WAC), and Nuclear Regulatory Commission (NRC) requirements under Framatome's NRC license SNM-1227.

2. Organization Responsibilities

A project manager will be responsible for project oversight, including ensuring that characterization, sampling, and analyses are performed according to this SAP. A project engineer will report to the project manager. The project engineer will determine sampling locations, oversee implementation of all activities related to this SAP, maintain detailed field notes, and act as the laboratory contact. Trained technicians from Framatome's Chemical and Waste Processing Product Center, Radiation Protection organization, and Analytical Services organization will perform sampling and analyses. An environmental engineer and health physicist from Framatome's Environmental, Health, Safety, and Licensing organization are part of the lagoon closure team and will help assure that the project meets all regulatory requirements.

3. Quality Assurance

The overall quality assurance objective is to ensure that data quality is sufficient to determine whether cleanup levels are met and to support decisions regarding waste disposition. To achieve that objective, field activities related to sampling will be conducted in accordance with the methods described herein. Analytical data generated by the sampling and analysis activities will be validated to ensure that the precision and accuracy of laboratory analytical results are within established guidelines. Collection of quality control samples is discussed in the following section.

4. **Sampling and Characterization**

Framatome will employ a field survey method utilizing Gamma Energy Analysis (GEA) and/or discrete sampling and laboratory analyses to characterize the contamination in the inter-liner sands and in the soils beneath the surface impoundment and sand trench/leach pit liners and to guide the removal of contaminated sands and soil. Sampling and analysis to confirm compliance with soil cleanup levels will be conducted on undisturbed soil using a random sampling strategy after excavation of contaminated soil has been completed. The washed sand and soil intended for return to the site as fill will be periodically sampled after it has been processed in the soil washing unit prior to being placed in staging piles. Sampling is described in detail in Section 4.2.2

A key premise in Framatome's characterization approach for lagoon subsoils and inter-liner sands is that radioactive uranium contamination will also be a reliable indicator of chemical contamination. This premise is based on the fact that chemical and radioactive (uranium) constituents have occurred together in waste solutions that have been managed in Framatome's surface impoundments. Uranium, because of its physical properties, is an excellent indicator constituent. Uranium is a metal that is not subject to degradation or volatilization; emits alpha, beta and gamma radiation; and tends to adhere to soil particles. The GEA survey method is superior to discrete sampling in that it examines 100% of the area surveyed and is much less likely to miss "hot spots" that could be passed over in any discrete sample collection approach.

As a practical consideration in proceeding with the cleanup, it is expected that the NRC and Ecology cleanup criteria for uranium contamination will assure that chemical contamination is also below MTCA Method B unrestricted release cleanup criteria. Likewise, sand and soil cleaned by soil washing to below uranium contamination limits is anticipated to be well below chemical contamination limits. This is because the nitrate, fluoride, sulfate, and ammonium salts that are the primary constituents of the chemical contamination are readily soluble in water and will be removed at least as well as uranium contamination in soil washing or other aqueous cleanup processes. These premises are being further tested and verified during the qualification of lagoon sampling and decontamination processes. It should be noted that the GEA radiological screening technology will be used as a practical tool to conservatively guide the soil/sand remediation activities. However, as described in Section 4.2.2 below, the adequacy of the cleanup action with respect to MTCA Method B cleanup limits will be verified by a final confirmation survey relying on collection and laboratory analysis of discrete soil samples.

4.1 *Documentation of Sampling Activities*

The following procedures are to be used by all field personnel when conducting sand and soil confirmational sampling activities in conjunction with the closure of the lagoons. All field activities will be documented in a bound field notebook using a pen with permanent ink. Information to be recorded in the notebook includes the following:

- Date
- Weather conditions
- Names of field team members
- Times of site arrival and departure
- Documentation of all field activities
- Any equipment malfunction
- An accurate depiction of the survey grid lines
- Sampling locations
- Sample information and GEA data
- The location of all radiologically contaminated areas
- Odd or unusual occurrences
- Site visitors

The field notebook will be signed by the Field Supervisor or Project Engineer at the end of each day of fieldwork. The sampling procedures are outlined in the following sections.

4.2 *Sampling Locations, Parameters, and Frequency*

4.2.1 Characterization Survey and Soil Removal

For the characterization survey, the floors and walls of the surface impoundments and sand trench/leach pit will be divided into survey units of a size to accommodate the sensitivity of the GEA collimation beam with respect to the uranium cleanup level. Preliminary testing has been performed with the GEA and grid spaces 10 ft. x 10 ft. appear to be the optimum size. The sampling plan and survey areas will be adjusted as necessary for presence of any holes or tears in the liner recorded in the liner removal process. This process will need to be applied first to the inter-liner sand layers and subsequently to the soil underlying the bottom liners. All sand will require removal and will be segregated for subsequent treatment based on its compliance with cleanup limits. Contaminated soil above the cleanup levels will be removed from a survey unit and the exposed soil below resurveyed and/or resampled until laboratory results confirm that the soil meets the applicable cleanup criteria. The lagoon closure qualification testing will be performed as part of the pre-closure activities (see 3.1.2) to determine the size of the survey units, verify the correlation between the GEA survey and discrete samples, and validate the link between chemical and radiological contamination with respect to cleanup levels.

The characterization activities relative to the sand layers and underlying soils are discussed in Sections 3.5.2 and 3.7.1, respectively, of the Closure Plan. All of the sand layers will require removal, at least on an interim basis, to allow access to the underlying liners and soil. The iterative process for removal of the soil is described in Section 3.7.2 of the Plan. As noted in the Plan, sand/soil characterization and removal will be guided by the cleanup levels for uranium, nitrates, and fluoride. Analyses for the organic constituents of concern will be reserved for the final confirmation survey.

4.2.2 Final Confirmational Sampling

A total of 350 discrete grab samples to be analyzed for nitrate, fluoride, and uranium will be taken from the overall surface impoundment and sand trench/leach pit area after the contaminated soil has been removed. An additional 28 samples will be analyzed for Freon 113, TCE, and acetone, In addition to the previous samples, 35 discrete grab samples will be taken from sand/soil that has been processed in the soil washing unit. These samples will be analyzed for nitrate, fluoride, and uranium. An additional subset of 8 samples will be taken from the washed sand/soil for Freon 113, TCE, and acetone. A detailed description of sampling methodology is found in Section 4.4, Sample Collection.

A random sampling strategy will be used to conduct the final confirmational sampling, with each surface impoundment and sand trench/leach pit area subdivided into a grid consisting of 20 ft. x 20 ft. squares (Figure B-1). The number of samples taken from each individual unit is based on the size of that unit, i.e., Lagoon 3 is the largest impoundment therefore more samples will be taken from its underlying soils than the other smaller lagoons. Each grid space from the individual unit will be uniquely numbered and a random number generator will be utilized to choose sample locations. Each sample location will be chosen independently of the other sample locations within the established grid for that particular unit. Listed below is the minimum number of samples that will be taken on the final confirmational sampling for each lagoon, the sand trench/leach pit, and the soil washing process:

Lagoon 1 – 51 fluoride, nitrate, uranium samples; 4 TCE, Freon 113, acetone samples

Lagoon 2 – 28 fluoride, nitrate, uranium samples; 3 TCE, Freon 113, acetone samples

Lagoon 3 – 88 fluoride, nitrate, uranium samples; 6 TCE, Freon 113, acetone samples

Lagoon 4 – 66 fluoride, nitrate, uranium samples; 4 TCE, Freon 113, acetone samples

Lagoon 5A – 51 fluoride, nitrate, uranium samples; 4 TCE, Freon 113, acetone samples

Lagoon 5B – 51 fluoride, nitrate, uranium samples; 4 TCE, Freon 113, acetone samples

Sand Trench – 12 fluoride, nitrate, uranium samples; 2 TCE, Freon 113, acetone samples

Leach Pit – 3 fluoride, nitrate, uranium samples; 1 TCE, Freon 113, acetone sample

Soil Washing – 5 fluoride, nitrate, uranium samples for each lagoon, 3 for the sand trench, and two for the leach pit; 1 TCE, Freon 113, acetone sample for each lagoon, sand trench, and leach pit

While judgement (discretionary) samples will be used in the characterization survey if there is knowledge of previous leaks or other indicators of contamination, only randomly selected sample locations will be used in the final confirmational sampling to show that cleanup levels have been met. In order to maintain completely random comfirmational sampling, all samples will be taken from the center of the randomly chosen grid space.

Interstitial sand/soil that has been processed through the soil washing unit will be periodically sampled to confirm that cleanup levels are met. Sand/soil will be sampled after it has passed through the washing unit prior to placement in storage piles. Thirty-five inorganic samples (five from each lagoon, three from the sand trench, two from the leach pit) will be taken. Additionally, one organic sample will be taken while processing sand/soil from each lagoon and the sand trench and leach pit. All sand/soil that is collected after washing will be stored pending verification that site cleanup levels have been met prior to replacing it into the excavation. An Ecology contained-in determination relative to Freon 113 and acetone is required for all sand/soil that has been washed prior to it being replaced into the excavation.

Final confirmational soil samples will be analyzed by the methods shown in Table B-1. If sample results, after statistical analyses on the final confirmational sample results have been completed, show that contamination is present above the pertinent MTCA Method B unrestricted land use cleanup levels, additional soil will be removed and additional confirmatory surveys and/or sampling will be performed. All soil that is removed for sampling will be evaluated per WAC 173-303 and NRC requirements and managed appropriately.

Upon completion of laboratory analyses, data validation, statistical analyses, contained-in determinations by Ecology for the remediated lagoon area and for sand/soils that will be replaced into the excavaton, and the final determination that soil cleanup levels have in fact been met, the washed sand/soil will be re-introduced into the excavation.

4.3 *Statistical Analyses of Final Characterization Sample Results*

A statistical approach will be used to determine if established cleanup levels for the identified constituents of concern have been met. Because the final characterization samples will be chosen on a random basis, the statistical approach serves as the best method to ensure that the surface impoundment area does in fact meet cleanup levels. In order to demonstrate compliance with the cleanup levels, three criteria must be met: 1) The upper 95% confidence limit on the true population mean (average) must be less than the cleanup level; 2) no sample concentration can be more than two times the established cleanup limit; and 3) less than 10% of the samples can exceed the cleanup level. Upon receipt of final characterization soil sample results, statistical analyses will be performed in regards to the three criteria listed above.

4.4 *Sample Collection*

4.4.1 Nitrate, Fluoride, Uranium Analytes From Lagoon Areas

After grid spaces are randomly chosen for sampling, they shall be clearly marked. The center of the 20’ x 20’ grids chosen for sampling will be the sampling location. The center of the grid space will be located by running a string from each corner of the grid to form an “x”. The point at which the strings overlap is where the sample will be taken. A 1 ft x1 ft x 3 inch deep sampling template will be placed at the chosen sample location, with the soil inside of the sampling template the focus of the intended sample. The soil will be collected using either a decontaminated stainless steel or plastic scoop, and placed into a bowl constructed of like material. The sample will then be homogenized with the scoop that was used for sample collection. The amount needed to fill the sample container(s) will be placed into either plastic or glass 250 ml container(s). All excess soil will be returned to the sampling location. Sample containers will be filled to the lip to minimize head space.

After filling, the sample container will be sealed immediately and placed in a cooler. Disturbance to the soil samples shall be minimized as much as possible. The volume of soil required for each type of laboratory analysis is specified in Table B-1.

4.4.2 Sand/Soil From Soil Washing Unit

Sand and soil that has been processed in the soil washing unit will be sampled after it has passed through the unit on a periodic basis. Five discrete samples will be taken while processing sand/soil from each lagoon, three while processing sand trench sand/soil, and two while processing leach pit sand/soil. The samples will be taken after the processing begins and will occur on separate days. These samples will be analyzed for nitrate, fluoride, and uranium. Also during this period, one sample of washed material will be taken from each lagoon, the sand trench, and the leach pit, which will be analyzed for TCE, Freon 113, and acetone.

4.4.3 Acetone, Freon 113, and TCE Sampling from Lagoon Areas

Sampling for the organic analytes, which include acetone, Freon 113, and TCE, will occur in randomly chosen locations using the same methodology as listed in section 4.2.2. Locations for organic sampling will be chosen independently of the inorganic sample locations. A total of 28 samples will be taken for organic constituents which includes four samples from under Lagoon 1, 4, 5A and 5B, three locations under Lagoon 2; six locations under Lagoon 3; two samples from the sand trench and one from the leach pit. The center of the grid space will be located by running a string from each corner of the grid to form an “x”. The point at which the strings overlap is where the sample will be taken. The discrete sample will be taken by digging 12” below the surface at the sample location. Once the excavation is 12” deep, soil will placed into the sample container until it is filled to the lip to minimize head space. After filling, the sample container will be sealed immediately and placed in a cooler.

4.5 *Sample Documentation*

A sample identification label which identifies the sample number, date and time of sampling, matrix, and initials of sampling personnel will be completed and affixed to each sample container immediately after that container has been filled with soil. An example of a sample label is provided in Figure B-2. The sample will be placed in a cooler with ice pending transport to the laboratory

4.6 *Quality Control Samples*

Quality control samples will consist of blind duplicates and equipment rinsate blanks. Blind duplicate samples will consist of samples from an identical location with different identifiers on the sample label. The laboratory will not be informed that duplicates have been submitted. Equipment rinsate blanks will be collected on a periodic basis at the end of each sampling day. Nano-pure water collected from Framatome's analytical laboratory will be poured over the decontaminated sampling scoop and collected into sample bottles for analysis of the analytes that were sampled on that specific day.

5. **Decontamination Procedures**

All sampling equipment will be decontaminated prior to use and after sampling at each location to avoid chemical cross-contamination of field samples. Equipment will be decontaminated by washing/scrubbing with a laboratory-grade, nonphosphate detergent solution and rinsing with deionized water. Rinsate water will be collected and managed appropriately. All field personnel will wear clean nitrite or vinyl gloves when conducting sampling and decontamination procedures.

6. **Sample Handling And Shipment Procedures**

A summary of the sample handling procedures, including holding times and SW-846 methods required for each type of soil analysis is provided in Table B-1. All soil samples will be stored in a cooler with ice immediately after collection. For off-site analyses the cooler of filled sample containers, along with sufficient ice to effectively cool the samples during shipment, will be transported either by overnight courier or FANP personnel to the selected laboratory for analysis. The selected laboratory shall be accredited under WAC 173-50.

6.1 *Chain of Custody Procedures*

All samples will remain in the custody of the sampling personnel during each sampling day. At the end of each sampling day and prior to the transfer of the samples to an overnight courier, chain-of-custody entries will be made for all samples using a Chain-of-Custody form (Figure B-3). One Chain-of-Custody form will be completed for each cooler of samples. All information on the Chain-of-Custody form and the sample container labels will be checked against the sampling log entries, and the samples will be recounted before transferring custody. Upon transfer of custody, the Chain-of -Custody form will be signed by the project engineer or field supervisor, sealed in plastic, and placed inside the sample cooler.

A signed, dated custody seal (Figure B-4) will be placed over the lid opening of the sample cooler to indicate if the cooler is opened during shipment. All Chain-of-Custody forms received by the laboratory must be signed and dated by the laboratory's sample custodian.

The custodian at the laboratory will note the condition of each sample received as well as questions or observations concerning sample integrity. The sample custodian will also maintain a sample tracking record that will follow each sample through all stages of laboratory processing. The sample tracking records must show the date of sample extraction and sample analysis. These records will be used to determine compliance with holding time limits during laboratory audits and data validation.

6.2 ***Data Validation***

Analytical results will be reviewed and validated. Appropriate data qualifier codes will be applied to those data for which quality control parameters do not meet acceptable standards. Data quality acceptance criteria are specified in the U.S. Environmental Protection Agency (USEPA) Laboratory Data Functional Guidelines.

7. **Confirmatory Sampling**

Any additional confirmatory sampling that may be conducted will be performed in accordance with the protocols established in this SAP. All guidelines and procedures will be adhered to as implemented in this SAP.

Table B-1 Summary of Sampling Requirements

Analyte	SW-846 Method	Container	Preservative	Hold Time
Fluoride (soluble)	340.2	250 ml glass or plastic	Cool 4 C	7 days extraction 28 days analysis
Nitrate (as N)	300.0	250 ml glass or plastic	Cool 4 C	7 days extraction 48 hours analysis
Uranium	ICP-MS	250 ml glass or plastic	-----	6 months
Freon 113	8260	250 ml glass	Cool 4C	14 days
Acetone	8260	250 ml glass	Cool 4C	14 days
Trichloroethylene	8260	250 ml glass	Cool 4C	14 days

Figure B-1 Lagoon Closure Grid Layout

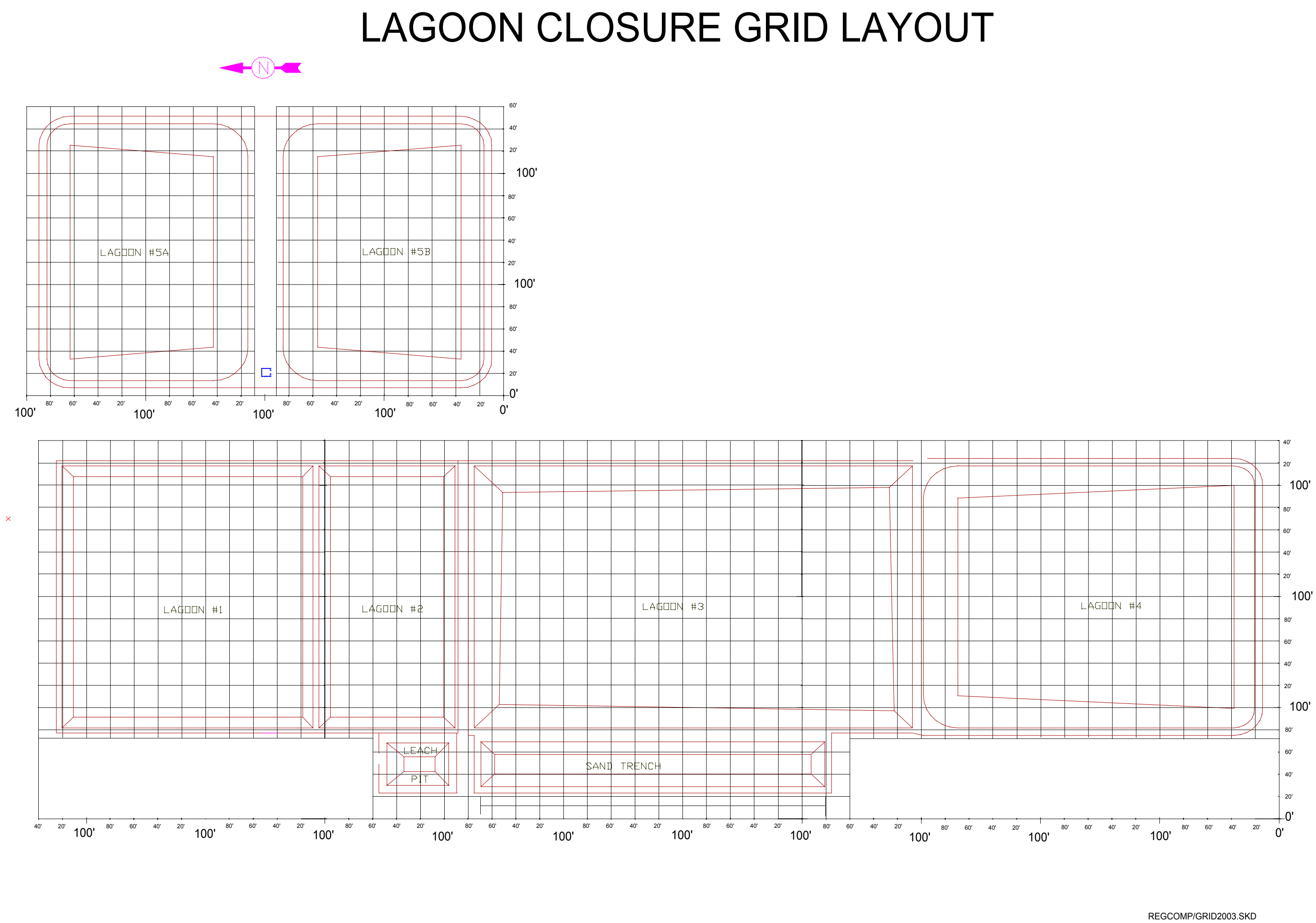


Figure B-2 Sample Label

Client: ______________________________

Date Sampled: ________ **Time:** ________

Source: ______________________________

Analysis: ______________________________

Unpreserved, Preserved ______________

Figure B-3 Chain of Custody Form

Framatome ANP Richland, Inc.
2101 Horn Rapids Road
Richland, WA 99352

ENVIRONMENTAL ANALYTICAL REQUEST & REPORT
CHAIN OF CUSTODY

LOCATION:		REPORT RESULTS TO:
SAMPLER	NAME:	ID:
	DATE:	TIME:
FIELD PARAMETERS	PH:	
	TEMPERATURE: °C	
	CONDUCTIVITY: µS	

LABORATORY ANALYSIS AND RESULTS

ANALYSIS	Cl-mg/L	F-mg/L	NH_3-N mg/L	NO_3-N mg/L	SO_4-mg/L	TDS-mg/L
METHOD	EPA-300.0	EPA-300.0	EPA-350.3	EPA-300.0	EPA-300.0	EPA-160.1

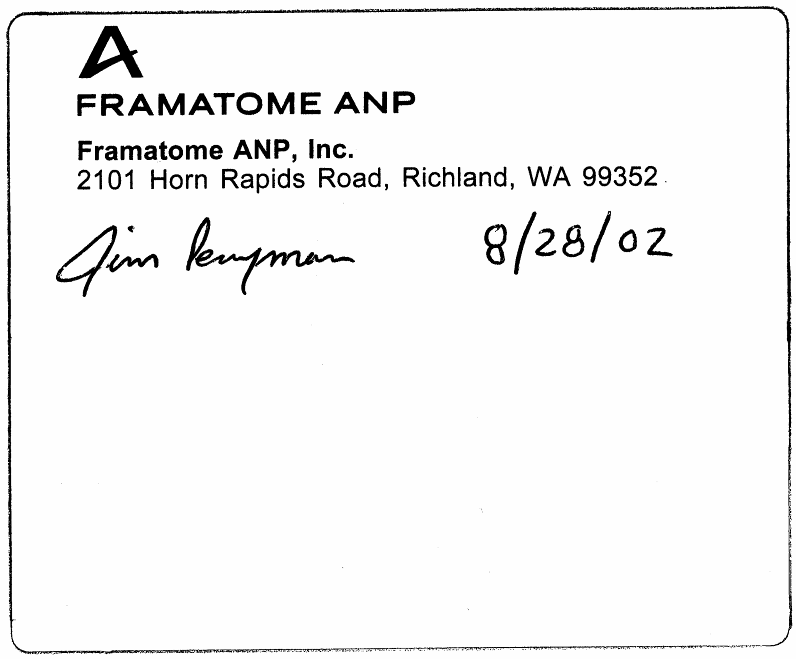
SAMPLE ID	GRAB	COMPOSITE	PRESERVED	LAB NUMBER	[X] CHECK ANALYSIS REQUESTED					
					☐	☐	☐	☐	☐	☐
NOTES:				COMPLETED Name ID						
				Date | Time						
SAMPLE ID	GRAB	COMPOSITE	PRESERVED	LAB NUMBER						
					☐	☐	☐	☐	☐	☐
NOTES:				COMPLETED Name ID						
				Date | Time						
SAMPLE ID	GRAB	COMPOSITE	PRESERVED	LAB NUMBER						
					☐	☐	☐	☐	☐	☐
NOTES:				COMPLETED Name ID						
				Date | Time						

RELINQUISHED BY: (Signature)	ID:	DATE:	TIME:	RELINQUISHED BY: (Signature)	ID:	DATE:	TIME:	RELINQUISHED BY: (Signature)	ID:	DATE:	TIME:
RECEIVED BY: (Signature)	ID:	DATE:	TIME:	RECEIVED BY: (Signature)	ID:	DATE:	TIME:	RECEIVED BY: (Signature)	ID:	DATE:	TIME:

LABORATORY REMARKS:	APPROVED BY (Signature):	DATE:

WHITE - Lab CANARY - Regulatory Compliance PINK - Submitter 3330998 Rev. 3 (03/2001)

Figure B-4 Chain of Custody Seal



FRAMATOME ANP

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8/28/02